C141-E201-01EN

MAT3300NC/NP
MAT3147NC/NP
MAT3073NC/NP

DISK DRIVES

PRODUCT/MAINTENANCE MANUAL

FUJITSU

FOR SAFE OPERATION

Handling of This manual

This manual contains important information for using this product. Read thoroughly before using the product. Use this product only after thoroughly reading and understanding especially the section "Important Alert Items" in this manual. Keep this manual handy, and keep it carefully.

FUJITSU makes every effort to prevent users and bystanders from being injured or from suffering damage to their property. Use the product according to this manual.

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The contents of this manual may be revised without prior notice.

REVISION RECORD		
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Related Standards

Product specifications and functions described in this manual comply with the following ANSI (*1) standards.

Document number	Title
T10/1236D Rev.20 [NCITS.351:2001]	SCSI Primary Commands-2 (SPC-2)
T10/996D Rev.8c [NCITS.306:1998]	SCSI-3 Block Commands (SBC)
T10/1157D Rev.20	SCSI Architecture Model-2 (SAM-2)
T10/1365D Rev.10	SCSI Parallel Interface-4 (SPI-4)

*1 ANSI = American National Standard Institute

In case of conflict between this manual and any referenced document, this manual takes precedence.

PREFACE

This manual describes the MAT3300NC/NP, MAT3147NC/NP, and MAT3073NC/NP 3.5 type fixed disk drives with an embedded SCSI controller.

This manual details the specifications and functions of the above disk drive, and gives the requirements and procedures for installing it into a host computer system.

This manual is written for users who have a basic understanding of fixed disk drives and their use in computer systems. The MANUAL ORGANIZATION section describes organization and scope of this manual. The need arises, use the other manuals.

OVERVIEW OF MANUAL

This manual consists of the following eight chapters:

CHAPTER 1 GENERAL DESCRIPTION

This chapter introduces the disk drives and discusses their standard features, hardware, and system configuration.

CHAPTER 2 SPECIFICATIONS

This chapter gives detailed specifications of the disk drives and their installation environment.

CHAPTER 3 DATA FORMAT

This chapter describes the data structure of the disk, the address method, and what to do about media defects.

CHAPTER 4 INSTALLATION REQUIREMENTS

This chapter describes the basic physical and electrical requirements for installing the disk drives.

CHAPTER 5 INSTALLATION

This chapter explains how to install the disk drives. It includes the notice and procedures for setting device number and operation modes, mounting the disk drive, connecting the cables, and confirming drive operation.

CHAPTER 6 DIAGNOSIS AND MAINTENANCE

This chapter describes the automatic diagnosis, and maintenance of the disk drive. This chapter also describes diagnostic methods for operation check and the basics of troubleshooting the disk drives.

CHAPTER 7 ERROR ANALYSIS

This chapter describes in details how collect the information for error analysis and how analyze collected error information.

APPENDIX A TO B

The appendixes give supplementary information, including a list of setting items and the signal assignments of interface connector.

CONVENTIONS FOR ALERT MESSAGES

This manual uses the following conventions for alerts to prevent physical or property damages to users or by standards.

⚠CAUTION	This indicates that either minor or moderate personal injury *may* occur if the user does not perform the procedure correctly.
NOTICE	This indicates that inconvenience to the user such as damages to the product, equipment, data, and/or other property may occur if the user does not pay attention or perform the procedure correctly.
IMPORTANT	This indicates information that the helps the user use the product more effectively.

CONVENTIONS USED IN THIS MANUAL

The MAT3300NC/NP, MAT3147NC/NP, and MAT3073NC/NP disk drives are described as "the intelligent disk drive (IDD)", "the drive" or "the device" in this manual.

Decimal number is represented normally.

Hexadecimal number is represented as X'17B9', 17B9h or 17B9H.

Binary number is represented as "010".

ATTENTION

Please forward any comments you may have regarding this manual.

To make this manual easier for users to understand, opinions from readers are needed. Please write your opinions or requests on the Comment at the back of this manual and forward it to the address described in the sheet.

Important Alert Items

Important Alert Messages

The important alert messages in this manual are as follows:

CAUTION

A hazardous situation *could* result in *minor* or *moderate personal injury* if the user does not perform the procedure correctly. This alert signal also indicates that damages to the product or other property *may* occur if the user does not perform the procedure correctly.

Task	Alert message	Page
Mounting Installation	*Data loss* *The drive adopts Reed-Solomon code for ECC.* *The sector-data is divided into 3 interleaving sectors, and ECC is performed in each sector where the maximum number of errors (up to 9 byte) can be corrected. [Total maximum byte: 9 byte* $\times$ *3 (interleave) = 27 byte]* *If the error of read sector keeps allowable error byte number, correction is performed.* *However, if error byte exceeds its allowable number, correction may not be performed properly.*	2-5
	Hot temperature *To prevent injury, do not handle the drive until after the device has cooled sufficiently after turning off the power. The DE and LSI become hot during operation and remain hot immediately after turning off the power.*	5-1
	Data loss *1. The user must not change the setting of terminals not described in this section. Do not change setting status set at factory shipment.* *2. Do not change the setting of terminals except following setting pins during the power is turned on.* • *Write protect: CN2 9-10 (NP model only)* *3. To short the setting terminal, use the short plug attached when the device is shipped from the factory.*	5-5
	Damage *1. Make sure that system power is off before connecting or disconnecting cables.* *2. Do not connect or disconnect cables when power is on.(except NC model)*	5-12

Task	Alert message	Page
Mounting Installation	*Damage* *1. Be careful of the insertion orientation of the SCSI connectors. With the system in which terminating resistor power is supplied via the SCSI cable, if the power is turned on, the overcurrent protection fuse of the terminating resistor power supplier may be blown or the cable may be burnt if overcurrent protection is not provided.* *When the recommended parts listed in Table 4.2 are used, inserting the cables in the wrong direction can be prevented.* *2. To connect SCSI devices, be careful of the connection position of the cable. Check that the SCSI device with the terminating resistor is the last device connected to the cable.*	5-12
	Data loss *When the SEND DIAGNOSTIC command terminates with the CHECK CONDITION status, the INIT must collect the error information using the REQUEST SENSE command. The RECEIVE DIAGNOSTIC RESULTS command cannot read out the error information detected in the self-diagnostics.*	6-4
	Caution *1. To avoid shocks, turn off the power before connecting or disconnecting a cable, connector, or plug.* *2. To avoid injury, do not touch the mechanical assembly during disk drive operation.* *3. Do not use solvents to clean the disk drive.*	6-5
	Caution *1. Always ground yourself with a wrist strap connected to ground before handling. ESD (Electrostatics Discharge) may cause the damage to the device.* *2. To prevent electrical damage to the disk drive, turn the power off before connecting or disconnecting a cable, connector, or plug.* *3. Do not remove a PCA. This operation is required to prevent unexpected or unpredictable operation.* *4. Do not use a conductive cleaner to clean a disk drive assembly.* *5. Ribbon cables are marked with a colored line. Connect the ribbon cable to a cable connector with the colored wire connected to pin 1.*	6-6
	Damage *Never open the disk enclosure in the field. Opening the disk enclosure may cause an irreparable fault.*	6-6
	Data loss *Save data stored on the disk drive before requesting repair. Fujitsu does not assume responsibility if data is destroyed during servicing or repair.*	6-7

MANUAL ORGANIZATION

PRODUCT/ MAINTENANCE MANUAL (This manual)	1. General Description 2. Specifications 3. Data Format 4. Installation Requirements 5. Installation 6. Diagnostics and Maintenance 7. Error Analysis
SCSI Physical Interface Specifications	1. SCSI Bus 2. SCSI Message 3. SCSI Bus Error Recovery Processing
SCSI Logical Interface Specifications	1. Command Processing 2. Data Buffer Management 3. Command Specification 4. Sense Data and error Recovery Procedure 5. Disk Medium Management

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CONTENTS

FIGURES

TABLES

CHAPTER 1 GENERAL DESCRIPTION

This chapter describes the feature and configuration of the intelligent disk drives (IDD).

IDDs are high performance large capacity 3.5 type fixed disk drives with an embedded SCSI controller.

The MAT series disk drives support the Small Computer System Interface (SCSI) as described in the ANSI SCSI SPI-4 [T10/1365D Rev.10] to the extent described in this manual.

The flexibility and expandability of the SCSI, as well as the powerful command set of the IDD, allow the user to construct a high-performance reliable disk subsystem with large storage capacity.

The data format can be changed from the format at factory shipment by reinitializing with the user's system. Refer to SCSI Logical Interface Specifications for details.

1.1 Standard Features

(1) Compactness

Since the SCSI controller circuit is embedded in the standard 3.5 type fixed disk drive form factor, the IDD is extremely compact. The IDD can be connected directly to the SCSI bus of the host system.

(2) SCSI standard

The IDD provides not only SCSI basic functions but also the following features:

- Arbitration
- Disconnection/Reconnection
- Data bus parity

The SCSI commands can manipulate data through logical block addressing regardless of the physical characteristics of the disk drive. This allows software to accommodate future expansion of system functions.

(3) 8-bit SCSI/16-bit SCSI

The IDD has 16-bit data bus width (16-bit SCSI), which have the wide transfer function suitable for SCSI-2. 8-bit data bus is available only with NP model.

See subsection 5.3.2 for details of the bus width setting.

For the ultra SCSI model, number of connectable SCSI devices on the same SCSI bus is varied as follows.

- 8-bit SCSI: 8 drives max. (option for NP model)
- 16-bit SCSI: 16 drives max.

(4) High speed data transfer

Such a high data transfer rate on the SCSI bus can be useful with the large capacity buffer in the IDD.

- 8-bit SCSI: The data transfer rate on the SCSI bus is 40 MB/s maximum at the synchronous mode.

- 16-bit SCSI: The data transfer rate on the SCSI bus is 320 MB/s maximum at the paced transfer synchronous mode.

Note:

The maximum data transfer rate in asynchronous mode may be limited by the response time of initiator and the length of SCSI bus length. The maximum data transfer rate in synchronous mode may be limited by the cable length, transmission characteristics of the SCSI bus and the connected SCSI device number.

(5) Continuous block processing

The addressing method of data blocks is logical block address. The initiator can access data by specifying block number in a logically continuous data space without concerning the physical structure of the track or cylinder boundaries.

The continuous processing up to [64K-1] blocks in a command can be achieved, and IDD can perform continuous read/write operation when processing data blocks on several tracks or cylinder.

(6) Programmable multi-segment data buffer

The data buffer is 8M bytes. Data is transferred between SCSI bus and disk media through this data buffer. This feature provides the suitable usage environment for users.

Since the initiator can control the disconnect/reconnect timing on the SCSI bus by specifying the condition of stored data to the data buffer or empty condition of the data buffer, the initiator can perform the effective input/output operations with utilizing high data transfer capability of the SCSI bus regardless of actual data transfer rate of the disk drive.

(7) Cache feature

After executing the READ command, the IDD reads automatically and stores (prefetches) the subsequent data blocks into the data buffer (Read-ahead caching).

The high speed sequential data access can be achieved by transferring the data from the data buffer without reaccessing the disk in case the subsequent command requests the prefetched data blocks.

The write cache feature is supported. When this feature is enabled, the status report is issued without waiting for completion of write processing to disk media, thereby enabling high speed write processing.

IMPORTANT

When Write cache is enabled, you should ensure that the cashed data is surely flushed to the disc media before you turn off the drive's power.
To ensure it, you should issue either the SYNCHRONIZE CASHE command or the STOP UNIT command with specifying "0" to the Immediate bit and then confirm that the command is surely terminated with the GOOD STATUS.

(8) Command queuing feature

The IDD can queue maximum 128 commands, and optimizes the issuing order of queued commands by the reordering function. This feature realizes the high speed processing.

(9) Reserve and release functions

The IDD can be accessed exclusively in the multi-host or multi-initiator environment by using the reserve and release functions.

(10) Error recovery

The IDD can try to recover from errors in SCSI bus or the disk drive using its powerful retry processing. If a recoverable data check occurs, error-free data can be transferred to the initiator after being corrected in the data buffer. The initiator software is released from the complicated error recover processing by these error recovery functions of the IDD.

(11) Automatic alternate block reassignment

If a defective data block is detected during read or write the IDD can automatically reassign its alternate data block.

(12) Programmable data block length

Data can be accessed in fixed-block length units. The data block length is programmable, and can be specified at initializing with a multiple of four within the range of 512 to 528 bytes.

IMPORTANT

Error rate increase
1. *The drive format at factory shipment is generally 512 byte.*
2. *The Recoverable Error of the drive might increase when the format would be modified from 512 bytes to the following values: 516 bytes, 520 bytes, 524 bytes, 528 bytes.*
3. *The Recoverable Error referred to here is sense data (1-13-xx).*

(13) Defective block slipping

A logical data block can be reallocated in a physical sequence by slipping the defective data block at formatting. This results in high speed contiguous data block processing without a revolution delay due to defective data block.

(14) High speed positioning

A rotary voice coil motor achieves fast positioning.

(15) Large capacity

A large capacity can be obtained from 3.5 type disk drives by dividing all cylinders into several partitions and changing the recording density on each partition (constant density recording). The disk subsystem with large capacity can be constructed in the good space efficiency.

(16) Start/Stop of spindle motor

Using the SCSI command, the host system can start and stop the spindle motor.

(17) Diagnosis

The IDD has a diagnostic capability which checks internal controller functions and drive operations to facilitate testing and repair.

(18) Low power consumption

By using highly integrated LSI components, the power consumption of the IDD is very low, and this enables the unit to be used in wide range of environmental conditions.

(19) Low noise and low vibration

The noise level is low; approx. 3.4 Bels Ready for the drive. This makes it ideal for office use.

(20) Microcode downloading

The IDD implements the microcode download feature. This feature achieves easy maintainability of the IDD and function enhancing.

1.2 Hardware Structure

An outer view of the IDD is given in Figures 1.1 and 1.2. The IDD is composed of the disk, head, spindle motor, mounted disk enclosure (DE) with actuator and air circulation filter, as well as read/write pre-amp with the printed circuit assembly (PCA) of the controller.

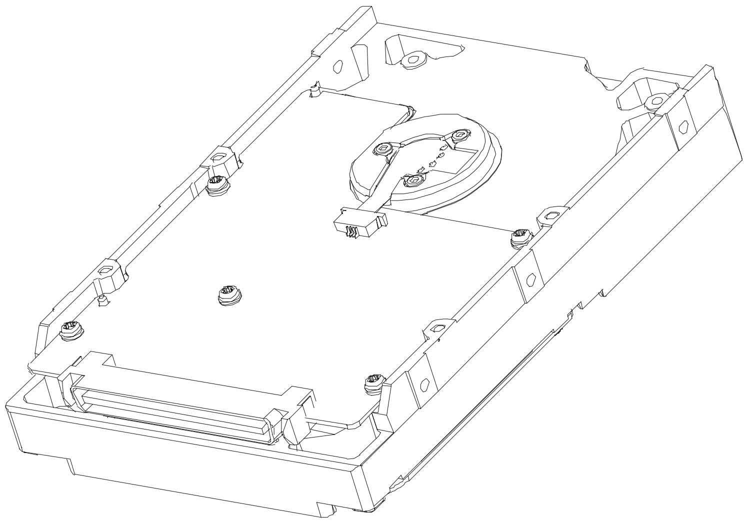


Figure 1.1 NC model drives outer view

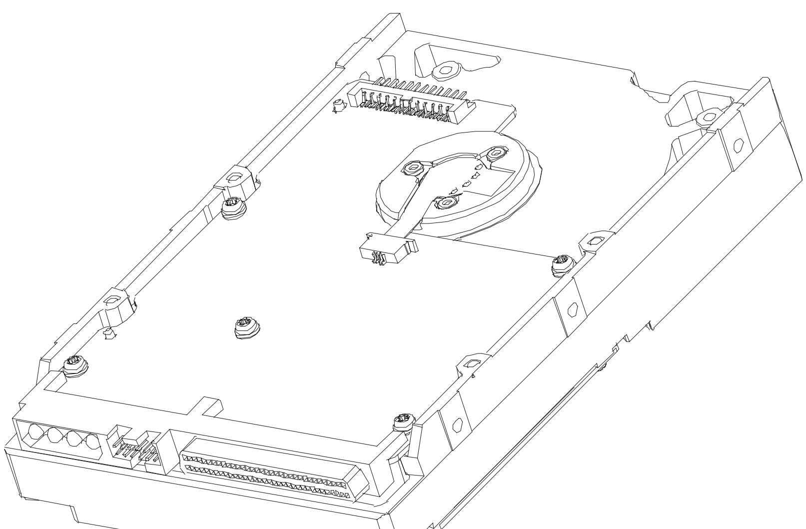


Figure 1.2 NP model drives outer view

(1) Disks

The disks have an outer diameter of 84 mm (3.3 inch) and an inner diameter of 25 mm (0.98 inch). The disks are good for at least 50,000 contact starts and stops.

(2) Heads

The MR (Magnet - Resistive) of the CSS (contact start/stop) type heads are in contact with the disks when the disks are not rotating, and automatically float when the rotation is started.

(3) Spindle motor

The disks are rotated by a direct-drive hall-less DC motor. The motor speed is controlled by a feedback circuit using the counter electromotive current to precisely maintain of the specified speed.

(4) Actuator

The actuator, which uses a rotary voice coil motor (VCM), consumes little power and generates little heat. The heads at the end of the actuator arm is controlled and positioned via feedback of servo information in the data.

The heads are positioned on the CCS zone over the disks when the power is off or the spindle motor is stopped.

(5) Air circulation (recirculation filter, breather filter)

The disk enclosure (DE) configures a clean room to keep out particle and other contaminants. The DE has a closed-loop air recirculation system. Using the movement of the rotating disks, air is continuously cycled through a filter. This filter will trap any particle floating inside the enclosure and keep the air inside the DE contaminant free. To prevent negative pressure in the vicinity of the spindle when the disks begin rotating, a breather filter is attached. The breather filter also equalizes the internal air pressure with the atmospheric pressure due to surrounding temperature changes.

(6) Read/write circuit

The read/write circuit utilizes a read channel mounted with a head IC that supports high-speed transmission and an MEEPR4ML (Modified Enhanced Extended Partial Response Class 4 Maximum Likelihood) modulation/demodulation circuit in order to prevent errors being triggered by external noise and to improve data reliability.

(7) Controller circuit

The controller circuit uses LSIs to increase the reliability and uses a high speed microprocessing unit (MPU) to increase the performance of the SCSI controller.

1.3 System Configuration

Figure 1.4 shows the system configuration. The IDDs are connected to the SCSI bus of host systems and are always operated as target. The IDDs perform input/output operation as specified by SCSI devices which operate as initiator.

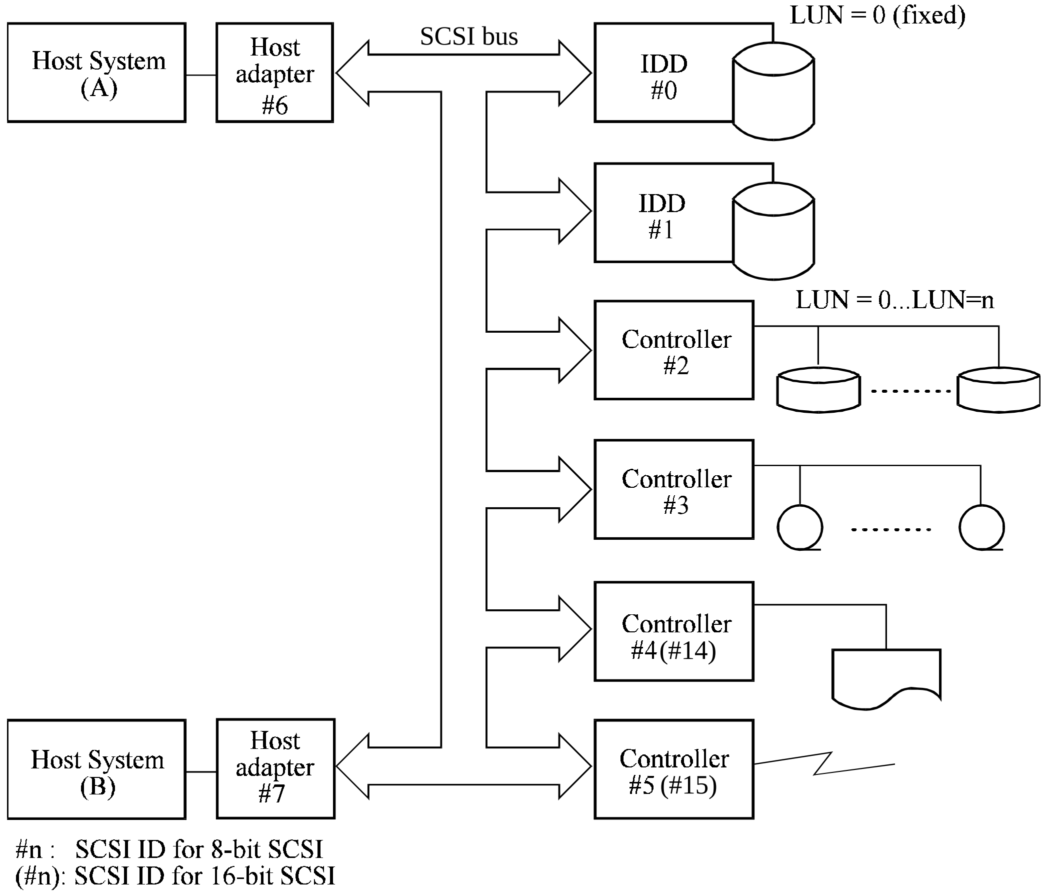


Figure 1.3 System configuration

(1) SCSI bus configuration

Up to eight SCSI devices operating as an initiator or a target can be connected to the SCSI bus for the 8-bit SCSI and up to 16 SCSI devices operating as an initiator or a target can be connected to the SCSI bus for the 16-bit SCSI in any combination.

For example, the system can be configured as multi-host system on which multiple host computers that operate as initiator or connected through the SCSI bus.

Using disconnect/reconnect function, concurrent input/output processing is possible on multi-SCSI devices.

(2) Addressing of peripheral device

Each SCSI device on the bus has its own unique address (SCSI ID:#n in Figure 1.4). For input/output operation, a peripheral device attached to the SCSI bus that operates as target is addressed in unit called as logical unit. A unique address (LUN: logical unit number) is assigned for each logical unit.

The initiator selects one SCSI device by specifying that SCSI ID, then specifies the LUN to select the peripheral device for input/output operation.

The IDD is constructed so that the whole volume of disk drive is a single logical unit, the selectable number of SCSI ID and LUN are as follows:

- SCSI ID: 8-bit SCSI:Selectable from 0 to 7 (option for NP model, switch selectable)
  16-bit SCSI:Selectable from 0 to 15 (switch selectable)

- LUN: 0 (fixed)

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CHAPTER 2 SPECIFICATIONS

This chapter describes specifications of the IDD and the functional specifications of the SCSI.

2.1 Hardware Specifications

2.1.1 Model name and order number

Each model has a different recording capacities and interface connector type when shipped. Table 2.1 lists the model name and order number.

The data format can be changed by reinitializing with the user's system.

Table 2.1 Model names and order numbers

Model name	Order number	SCSI type	Capacity (user area)
MAT3300NC	CA06350-B400	SCA2, LVD	300.0GB (*)
MAT3300NP	CA06350-B460	68-pin, LVD	
MAT3147NC	CA06350-B200	SCA2, LVD	147.0GB (*)
MAT3147NP	CA06350-B260	68-pin, LVD	
MAT3073NC	CA06350-B100	SCA2, LVD	73.5GB (*)
MAT3073NP	CA06350-B160	68-pin, LVD	

(*) 1GB=1,000,000,000 bytes

2.1.2 Function specifications

Table 2.2 shows the function specifications of the IDD.

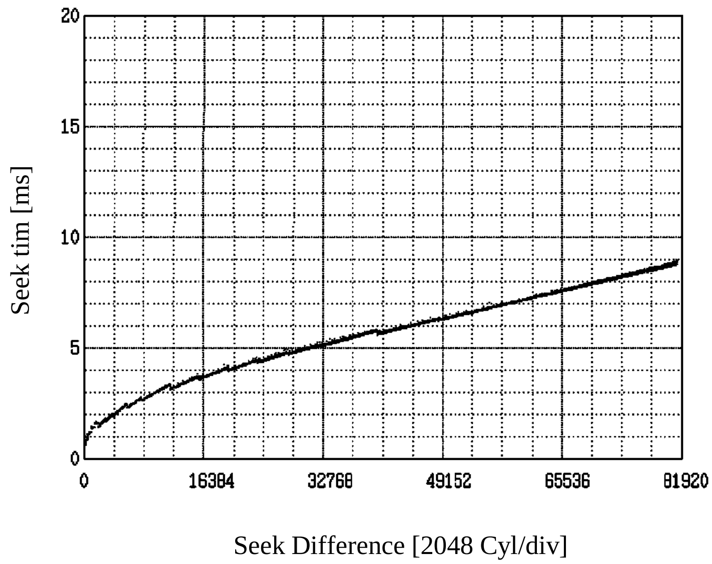
Table 2.2 Function specifications

Item		Specification		
		MAT3300NC/NP	MAT3147NC/NP	MAT3073NC/NP
Formatted capacity/device (*1)		300.0 GB (*11)	147.0 GB (*11)	73.5 GB (*11)
Number of disks		4	3	1
Number of heads		8	5	2
Number of rotations min^{-1} (rpm)		10,025 ± 0.2%		
Average latency time		2.99 msec		
Seek time (*3) (Read/Write)	Track to Track	0.2 ms/0.4 ms		
	Average	4.5 ms/5.0 ms		
	Full stroke	10.0 ms/11.0 ms		
Start/stop time (*4)	Start time	30 s typ. (60 s max.)		
	Stop time	30 s typ.		
Recording mode		32/34 MEEPRML		
External dimensions	Height:	25.4 mm		
	Width:	101.6 mm		
	Depth:	146.0 mm		
Weight (max)		0.75 kg		
Power consumption (*5)		9.5 W		
Inter-face	Single-Ended: Fast 5 SCSI	Cable length: 6 m max		
	Single-Ended: Fast 10 SCSI	Cable length: 3 m max		
	Single-Ended: Fast 20 SCSI	Cable length: 3 m max (*6) Cable length: 1.5 m max (*7)		
	LVD: Ultra 2 Wide U160 U320	Cable length: 25 m max (*8) Cable length: 12 m max (*9)		
Areal density		60 to 75 Gbits/inch^2		
Data transfer rate (*10)	Disk drive	132.4 MB/s		
	SCSI (Synchronous mode)	320 MB/s max.		
Logical data block length		512 to 528 byte (Fixed length)		
SCSI command specification		SPI-4 (T10/1365D Rev.10), SAM-2 (T10/1157D Rev.20), SPC-2 (T10/1236D Rev.20), SBC (T10/996D Rev.8c)		
Data buffer		8 MB FIFO ring buffer (*12)		
Acostic noise (Ready)		3.4 Bels typ.		

(*1) The formatted capacity can be changed by changing the logical block length and using spare sector space. See Chapter 3 for the further information. The formatted capacity listed in the table is an estimate for 512 bytes per sector.

(*2) The number of user cylinders indicates the max., and includes the alternate cylinder. The number of user cylinders and alternate cylinders can be specified at format of the IDD.

(*3) The positioning time is as follows:



(*4) The start time is the time from power on or start command to when the IDD is ready, and the stop time is the time for disks to completely stop from power off or stop command.

(*5) This value indicates at ready mode. Power supply at nominal voltage ± 1%. 25°C ambient.

(*6) Up to 4 SCSI devices having capacitance of 25pF or less can use cable length of up to 3.0 m.

(*7) 5 to 8 SCSI devices having capacitance of 25pF or less can use cable length of up to 1.5 m.

(*8) 1 on 1 connection case.

(*9) 1 host, 15 devices case.

(*10) The maximum data transfer rate may be restricted to the response speed of initiator and by transmission characteristics.

(*11) 1GB=1,000,000,000 bytes

(*12) 1MB=1,048,576 bytes

2.1.3 Environmental specifications

Table 2.3 lists environmental and power requirements.

Table 2.3 Environmental/power requirements

Item			Specification		
			MAT3300NC/NP	MAT3147NC/NP	MAT3073NC/NP
Temperature (*1)	Operating		5 to 55°C		
	Non-operating		–40 to 70°C		
	Transport (within a week)		–40 to 70°C		
	DE surface temperature at operating		5 to 60°C		
	Gradient		15°C/h or less		
Relative humidity	Operating		5 to 95%RH		
	Non operating		5 to 95%RH		
	Transport (within a week)		5 to 95%RH		
	Maximum wet bulb temperature		29°C (no condensation)		
Vibration (*2)	Operating (*3)		0.6 mm (5 to 20Hz)/9.8 m/s^2 (1G) (20 to 300 Hz) or less		
	Non-operating (*4)		3.1 mm (5 to 20Hz)/49m/s^2 (5G) (20 to 300Hz) or less		
	Transport (packaged)		3.1 mm (5 to 20Hz)/49m/s^2 (5G) (20 to 300Hz) or less		
Shock (*2)	Operating		637.4m/s^2 (65G) (2 ms)		
	Non-operating		2205m/s^2 (225G) (2 ms)		
	Transport (packaged)		2205m/s^2 (225G) (2 ms)		
Altitute (above sea level)	Operating		–305 to +3,048 m (-1,000 to +10,000 feet)		
	Non-operating		–305 to +12,192 m (-1,000 to +40,000 feet)		
Power requirements Input power (*5)	+12 VDC ±5%	Ready (Average)	0.6 A		
		Peak within 100 µs at spin-up	3.0 A		
		Random W/R (about 80 IOPS)	1.0 A		
	+5 VDC ±5% (*6)	Ready	0.46 A		
		Random W/R (about 80 IOPS)	1.0 A		
	Ripple (*7)		+5 V/+12 V 250 mVp-p		

(*1) For detail condition, see Section 4.1.

(*2) Vibration applied to the drive is measured at near the mounting screw hole on the frame as much as possible.

(*3) At random seek write/read and default on retry setting with log sweep vibration.

(*4) At power-off state after installation
Vibration displacement should be less than 2.5 mm.

(*5) Input voltages are specified at the drive connector side, during drive ready state.

(*6) The terminator power pin (SCSI connector) which supplies power to other terminators is not used (See Section 4.3).

(*7) High frequency noise (over 20 MHz) is less than 100 mVp-p.

2.1.4 Error rate

Errors detected during initialization and replaced by alternate block assignments are not included in the error rate. Data blocks to be accessed should be distributed over the disk medium equally.

(1) Unrecoverable error rate

Errors which cannot be recovered within 63 retries and ECC correction should not exceed 1 per 10^{15} bits.

⚠CAUTION

Data loss
The drive adopts Reed-Solomon code for ECC. The sector-data is divided into 3 interleaving sectors, and ECC is performed in each sector where the maximum number of errors (up to 9 byte) can be corrected. [Total maximum byte: 9 byte × 3 (interleave) = 27 byte]
If the error of read sector keeps allowable error byte number, correction is performed. However, if error byte exceeds its allowable number, correction may not be performed properly.

(2) Positioning error rate

Positioning errors which can be recovered by one retry should be 10 or less per 10^8 seeks.

2.1.5 Reliability

(1) Mean Time Between Failures (MTBF)

MTBF of the IDD during its life time is 1,2000,000 hours (operating: 24 hours/day, 7 days/week average DE surface temperature: 50°C or less).

Note:

The MTBF is defined as:

$$\text{MTBF}=\frac{\text{Operating time (hours) at all field sites}}{\text{The number of equipment failures from all field sites}}$$

Failure of the equipment means failure that requires repair, adjustments, or replacement. Mishandling by the operator, failures due to bad environmental conditions, power trouble, host system trouble, cable failures, or other failures not caused by the equipment are not considered.

(2) Mean Time to Repair (MTTR)

MTTR is the average time taken by a well-trained service mechanic to diagnose and repair a drive malfunction. The drive is designed for a MTTR of 30 minutes or less.

(3) Service life

The service life under suitable conditions and treatment is as follows.

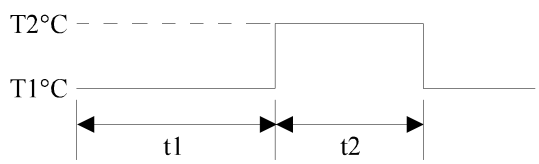
The service life is depending on the environment temperature. Therefore, the user must design the system cabinet so that the average DE surface temperature is as possible as low.

- DE surface temperature: 40°C or less — 5 years
- DE surface temperature: 41°C to 45°C — 4.5 years
- DE surface temperature: 46°C to 50°C — 4 years
- DE surface temperature: 51°C to 55°C — 3.5 years
- DE surface temperature: 56°C to 60°C — 3 years
- DE surface temperature: 61°C and more — Strengthen cooling power so that DE surface temperature is 60°C or less.

Even if the IDD is used intermittently, the longest service life is 5 years.

Note:

The "average DE surface temperature" means the average temperature at the DE surface throughout the year when the IDD is operating.



$$\text{Average DE surface temperature} = \frac{T1 \times t1 + T2 \times t2}{t1 + t2}$$

(4) Data security at power failure

Integrity of the data on the disk is guaranteed against all forms of DC power failure except on blocks where a write operation is being performed. The above does not applied to formatting disks or assigning alternate blocks.

2.2 SCSI Function Specifications

Table 2.4 shows the SCSI functions provided with the IDD.

Table 2.4 SCSI function specifications

Item			Specification
Electrical requirements (*1)	Single-ended type		O
	HVD type (High Voltage Differential)		×
	LVD type (Low Voltage Differential)		O
	Single-ended type	Position where the terminating resistor is mounted on the PCA	×
	Differential type	Position where the terminating resistor is mounted on the PCA	×
	TERMPWR signal send function		O (NP model)
Connector	68 pin P cable connector		O (NP model)
	80 pin SCA2 connector		O (NC model)
Data bus parity (Data bus CRC)			O
Bus arbitration function			O
Disconnection/reconnection function			O
Addressing	SCSI ID 16-bit SCSI		#0 to #15 (Jumper selection, NP model)
	LUN (logical unit number)		#0 fixed
Data transfer (Synchronous mode)	8-bit SCSI (Single-ended type) (Ultra 2 type) 16-bit SCSI (Single-ended type) (Ultra 2 Wide type) (U160 LVD type) (U320 LVD type)		O 20 MB/s max. O 40 MB/s max. O 40 MB/s max. O 80 MB/s max. O 160 MB/s max. O 320 MB/s max.
Data buffer			8 MB
Data block length (Logical data length=Physical data length) (*2)			512 to 528 bytes (Fixed length)

O : Provided × : Not provided

(*1) The driver mode (Single-ended or LVD) changes automatically by Diffsence signal level.

(*2) Refer to (12) of Section 1.1.

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CHAPTER 3 DATA FORMAT

This chapter explains data space definition, logical data block addressing, and defect management on the IDD.

3.1 Data Space

The IDD manages the entire data storage area divided into the following three data spaces.

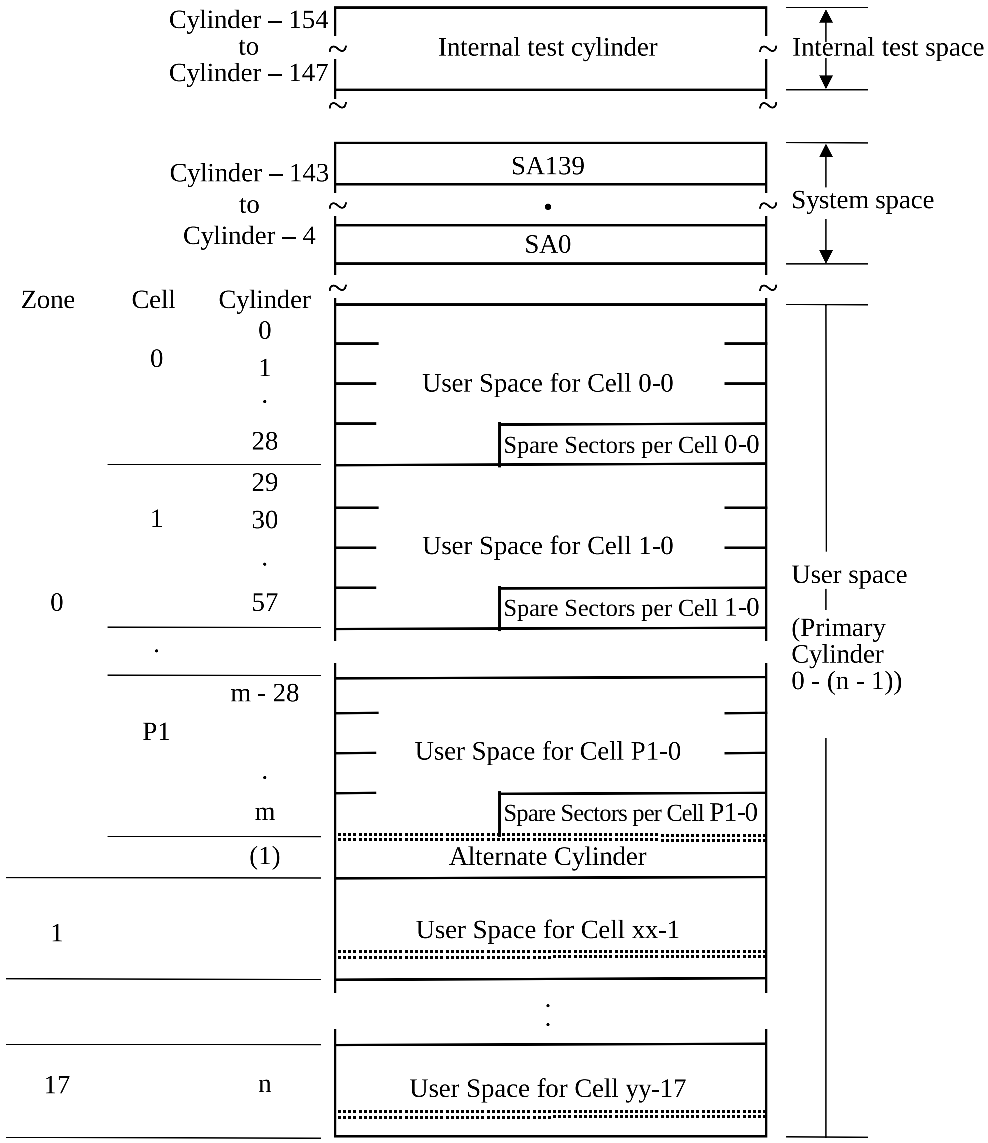
- User space: Storage area for user data
- Internal test space: Reserved area for diagnostic purposes
- System space: Area for exclusive use of IDD itself

The user space allows a user access by specifying data. These space can be accessed with the logical data block addressing method described in Section 3.2. The internal test space is used by Read/write test of self-diagnostics test, but user can't use direct access. The system space is accessed inside the IDD at power-on or during the execution of a specific command, but the user cannot directly access the system space.

3.1.1 Cylinder configuration

The IDD allocates cylinders to the user space, Internal test space, and system space. Figure 3.1 is the cylinder configuration.

Spare areas (alternate areas) for defective sectors are provided in the user space. Several sectors in the last track of one cell and several cylinders (alternate cylinders) in the user space are allocated as alternate areas according to the user's assignment (MODE SELECT command). See Subsection 3.1.2 for details.



Note: Spare sectors on the last track in each cylinder are not necessarily placed at the end of the track because of a track skew or a cylinder skew. (Details are explained in Subsection 3.1.3.)

Figure 3.1 Cylinder configuration

Apart from the above logical configuration, the IDD intends to increase the storage capacity by dividing all cylinders into several zones and changing a recording density of each zone.

(1) User space
The user space is a storage area for user data. The data format on the user space (the length of data block and the number of data blocks) can be specified with the MODE SELECT or MODE SELECT EXTENDED command.

The user can also specify the number of logical data blocks to be placed in the user space with the MODE SELECT or MODE SELECT EXTENDED command. When the number of logical data blocks is specified, as many cylinders as required to place the specified data blocks are allocated in the user space.

A number starting with 0 is assigned to each cylinder required in the user space in ascending order. If the number of cylinders do not reach the maximum, the rest of the cylinders will not be used.

Always one cylinder that is located at the end of each zone in the user space can be established as an alternate cylinder. Alternate cylinders will be used for alternate blocks when primary cylinders in the user space are used up. See Subsections 3.1.2 and 3.3.2 for details.

(2) Internal test space

The Internal test space is an area for diagnostic purposes only and its data block length is always 512KByte. The Internal test space consists of 8 cylinders and outer-host cylinder is always assigned (Cylinder –147 to –154). The user cannot change the number of cylinders in the Internal test space or their positions.

(3) System space

The system space is an area for exclusive use of the IDD itself and the following information are recorded.

- Defect list (P list and G list)
- MODE SELECT parameter (saved value)
- Statistical information (log data)
- Controller control information

The above information is duplicated in several different locations for safety.

Note:

The system space is also called SA space.

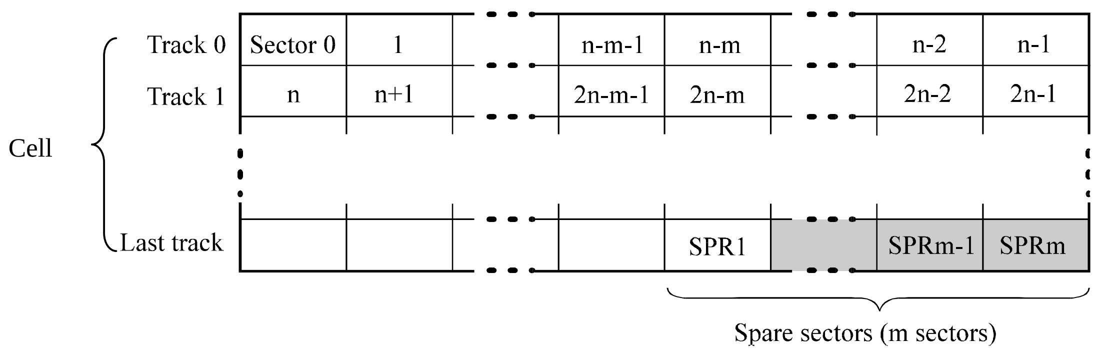
3.1.2 Alternate spare area

The alternate spare area consists of the last track of each cell in the user space and an alternate cylinder allocated to the last cylinder of each zone.

The spare area in each cell is placed at the end of the last track as shown in Figure 3.2. These spare sectors are located in the end of the track logically, not necessarily located at the end physically because of track skew or cylinder skew. (Details are explained on Subsection 3.1.3.)

Size can be specified by the MODE SELECT command.

The number of spare sectors per cell can be specified from 0 to 240. The default for the spare sectors number is 240.

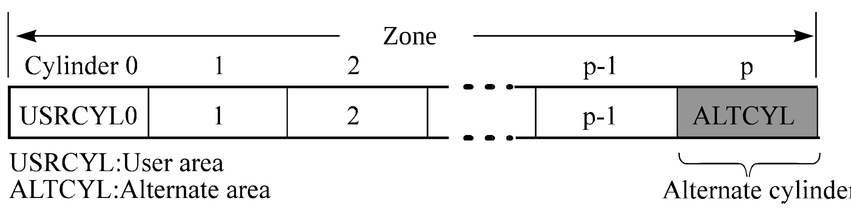


Note: This drive manages alternate spare areas for each cell, which is a set of cylinders. One cell consists of 29 cylinders.

Figure 3.2 Spare area in cell

An alternate cylinder is used when spare sectors in a cell are used up or 0 is specified as the number of spare sectors in a cell. 1 cylinder at the end of each zone of the user space is allocated as alternate cylinders as shown in Figure 3.3.

The user space and the system space share the alternate cylinders.



Note: The number of alternate cylinders can not be changed.

Figure 3.3 Alternate cylinder

3.1.3 Track format

(1) Physical sector allocation

Figure 3.4 shows the allocation of the physical sectors in a track. The length in bytes of each physical sector and the number of sectors per track vary depending on the logical data block length. The unused area (G4) exists at the end of the track in formats with most logical data block lengths.

The interval of the sector pulse (length of the physical sector) is decided by multiple of 50MHz free running frequency. This clock is not equal to the interval of the byte clock for each zone. Therefore, the physical sector length cannot be described with a byte length.

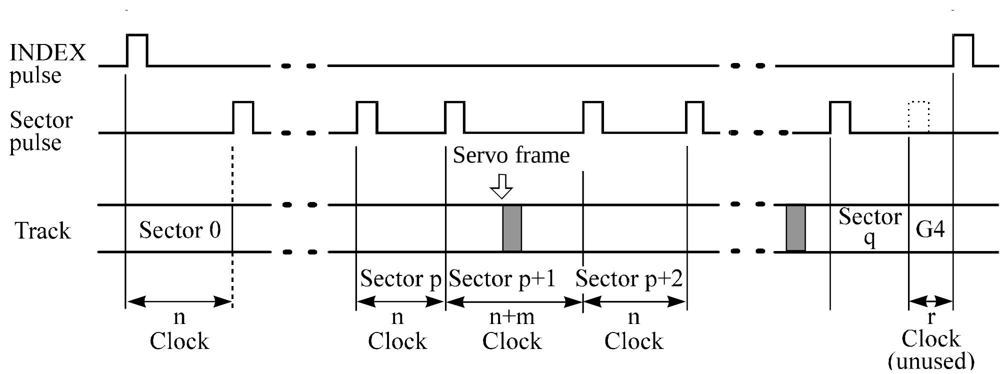


Figure 3.4 Track format

(2) Track skew and head skew

To avoid waiting for one turn involved in head and cylinder switching, the first logical data block in each track is shifted by the number of sectors (track skew and head skew) corresponding to the switching time. Figure 3.5 shows how the data block is allocated in each track.

At the head switching location in a cylinder, the first logical data block in track t + 1 is allocated at the sector position which locates the track skew behind the sector position of the last logical data block sector in track t.

At the cylinder switching location, like the head switching location, the first logical data block in a cylinder is allocated at the sector position which locates the head skew behind the last logical sector position in the preceding cylinder. The last logical sector in the cylinder is allocated when formatting, and is an unused spare sector.

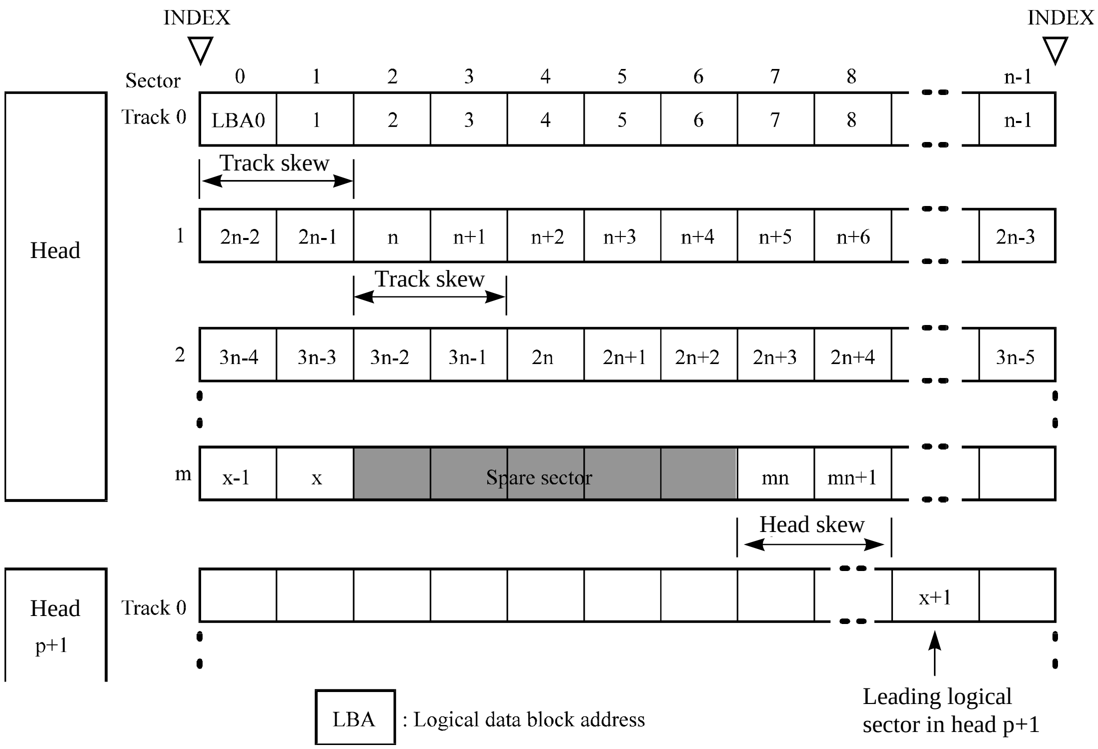


Figure 3.5 Track skew/head skew

The number of physical sectors (track skew factor and head skew factor) corresponding to the skew time varies depending on the logical data block length because the track skew and the head skew are managed for individual sectors. The IDD automatically determines appropriate values for the track skew factor and the head skew factor according to the specified logical data block length. The value can be read out by the MODE SENSE or MODE SENSE EXTENDED command after the track has been formatted.

3.1.4 Sector format

Each sector on the track consists of an ID field, a data field, and a gap field which separates them. Figure 3.6 gives sector format examples.

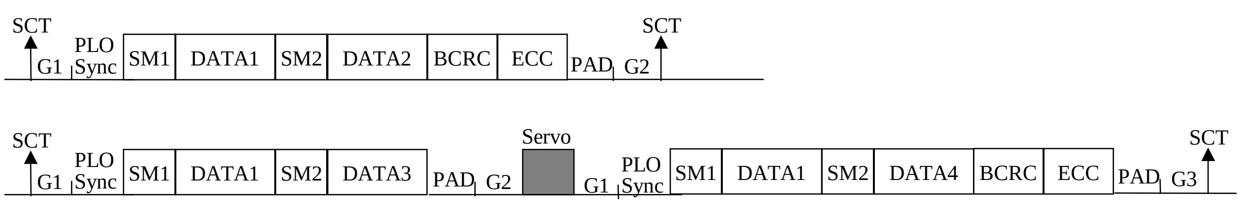


Figure 3.6 Sector format

Each sector on the track consists of the following fields:

(1) Gaps (G1, G2, G3)

No pattern is written on the gap field.

(2) PLO Sync

In this field, pattern X'00' in the specified length in bytes is written.

(3) Sync Mark (SM1, SM2)

In this field, special pattern in the specified length in bytes is written. This special pattern indicates the beginning of the data field.

(4) Data field (DATA1-DATA4)

User data is stored in the data field of the sector. The length of the data field is equal to that of the logical data block which is specified with a parameter in the MODE SELECT command. Any multiple of 4 between 512 and 528 bytes can be specified as the length.

(5) BCRC

It is a 4-byte error detection code. Errors in the ID field. Single burst errors with lengths of up to 32 bits for each logical block can be detected.

(6) ECC

This is the 54 byte code that allows detection and correction of errors in the data field, which is capable of correcting the single burst error up to 216 bits max. on the fly.

(7) PAD

In this field, pattern X'00' in the specified length in bytes is written. This field includes the variation by rotation and circuit delay till reading/writing.

3.1.5 Format capacity

The size of the usable area for storing user data on the IDD (format capacity) varies according to the logical data block or the size of the spare sector area. Table 3.1 lists examples of the format capacity when the typical logical data block length and the default spare area are used. The following is the general formula to calculate the format capacity.

[Number of sectors of each zone] = [number of sectors per track × number of tracks per cell – number of alternate spare sectors per cell] × [number of cells in the zone]

[Formatted capacity] = [total of sectors of all zones] ÷ [number of physical sectors in logical block] × [logical data block length]

The following formula must be used when the number of logical data blocks are specified with the parameter in the MODE SELECT or MODE SELECT EXTENDED command.

[Format capacity] = [logical data block length] × [number of logical data blocks]

The logical data block length, the maximum logical block address, and the number of the logical data blocks can be read out by a READ CAPACITY, MODE SENSE, or MODE SENSE EXTENDED command after initializing the disk medium.

Table 3.1 Format capacity

Model	Data block length	User blocks	Format capacity (GB)
MAT3300NC/NP	512	585,937,500	300.0 (*)
MAT3147NC/NP		287,277,984	147.0 (*)
MAT3073NC/NP		143,638,992	73.5 (*)

(*) 1GB=1,000,000,000 bytes

Note:

Total number of spare sectors is calculated by adding the number of spare sectors in each primary cylinder and the number of sectors in the alternate cylinders.

3.2 Logical Data Block Addressing

Independently of the physical structure of the disk drive, the IDD adopts the logical data block addressing as a data access method on the disk medium. The IDD relates a logical data block address to each physical sector at formatting. Data on the disk medium is accessed in logical data block units. The INIT specifies the data to be accessed using the logical data block address of that data.

The logical data block addressing is a function whereby individual data blocks are given addresses of serial binaries in each drive.

(1) Block address of user space

The logical data block address number is consecutively assigned to all of the data blocks in the user space starting with 0 to the first data block.

The IDD treats sector 0, track 0, cylinder 0 as the first logical data block. The data block is allocated in ascending order of addresses in the following sequence (refer to Figure 3.5):

1) Logical data blocks are assigned in ascending order of sector number in the same track.

2) Subsequent logical data blocks are assigned to sectors in every track except the last track in ascending order of track number in the same track (head). Within the same track, logical data blocks are assigned in the same way as step 1).

3) Subsequent logical data blocks are assigned to sectors in every track except the last track in ascending order of track number in the same cell. Within the same track, logical data blocks are assigned in the same way as step 1).

4) For the last track in the same cell, subsequent logical data blocks are assigned to sectors other than spare sectors in ascending order of sector number.

5) After blocks have been assigned in the same cell according to steps 1) to 4), subsequent logical data blocks are assigned in ascending order of cell number in the same way as in steps 1) to 4). Logical data blocks are assigned starting from track 0 in the next cell until the last cylinder (immediately preceding the alternate cylinder n-1 shown in Figure 3.1) of the zone except alternate cylinders in cells in the user space.

When the logical data block is allocated, some sectors (track skew and head skew) shown in Figure 3.5 are provided to avoid waiting for one turn involving head and cylinder switching at the location where the track or the head is physically switched.

See Subsection 3.3.2 for defective/alternate block treatment and the logical data block allocation method in case of defective sectors exist on the disk.

(2) Alternate area

Alternate areas in the user space (spare sectors in the cell and alternate cylinders) are not included in the above logical data block addresses. Access to sectors which are allocated as an alternate block in the alternate area is made automatically by means of IDD sector slip treatment or alternate block treatment (explained in Subsection 3.3.2), so the user does not have to worry about accessing the alternate area. The user cannot access with specifying the data block on the alternate area explicitly.

3.3 Defect Management

3.3.1 Defect list

Information of the defect location on the disk is managed by the defect list. The following are defect lists which the IDD manages.

- P list (Primary defect list): This list consists of defect location information available at the disk drive shipment and is recorded in a system space. The defects in this list are permanent, so the INIT must execute the alternate block allocation using this list when initializing the disk.

- D list (Data defect list): This list consists of defect location information specified in a FORMAT UNIT command by the INIT at the initialization of the disk. This information is recorded in the system space of the disk drive as the G list. To execute the alternate block allocation, the FORMAT UNIT command must be specified.

- G list (Growth defect list): This list consists of defective logical data block location information specified in a REASSIGN BLOCKS command by the INIT, information on defective logical data blocks assigned alternate blocks by means of IDD automatic alternate block allocation, information specified as the D list, and information generated as the C list. They are recorded in the system space on the disk drive.

The INIT can read out the contents of the P and G lists by the READ DEFECT DATA command.

3.3.2 Alternate block allocation

The alternate data block is allocated to a defective data block (= sectors) in defective sector units by means of the defect management method inside the IDD.

The INIT can access all logical data blocks in the user space, as long as there is no error.

Spare sectors to which alternate blocks are allocated can be provided in "alternate cylinders". See Subsection 3.1.2 for details.

The INIT can specify the size and area for spare sectors by the MODE SELECT command at the time of the initialization of the disk.

Both of the following are applicable to the alternate block allocation.

- Sector slip treatment: Defective sectors are skipped and the logical data block corresponding to those sectors is allocated to the next physical sectors. This treatment is made on the same cell as the defective sector's and is effective until all spare sectors in that cell are used up.

- Alternate sector treatment: The logical data block corresponding to defective sectors is allocated to unused spare sectors in the alternate cylinder.

The alternate block allocation is executed by the FORMAT UNIT command, the REASSIGN BLOCKS command, or the automatic alternate block allocation. Refer to OEM Manual–SCSI Logical Specifications–for details of specifications on these commands. The logical data block is allocated to the next physically continued sectors after the above sector slip treatment is made. On the other hand, the logical data block is allocated to spare sectors which are not physically consecutive to the adjacent logical data blocks. If a command which processes several logical data blocks is specified, the IDD processes those blocks in ascending order of logical data block.

(1) Alternate block allocation during FORMAT UNIT command execution

When the FORMAT UNIT command is specified, the allocation of the alternate block to those defective sectors included in the specified lists (P, G, or D) is continued until all spare sectors in the same cell are used up. When they are used up, unused spare sectors in the alternate cylinder are allocated to the subsequent sectors in the cylinder by means of alternate sector treatment. Figure 3.7 is examples of the alternate block allocation during the FORMAT UNIT command execution.

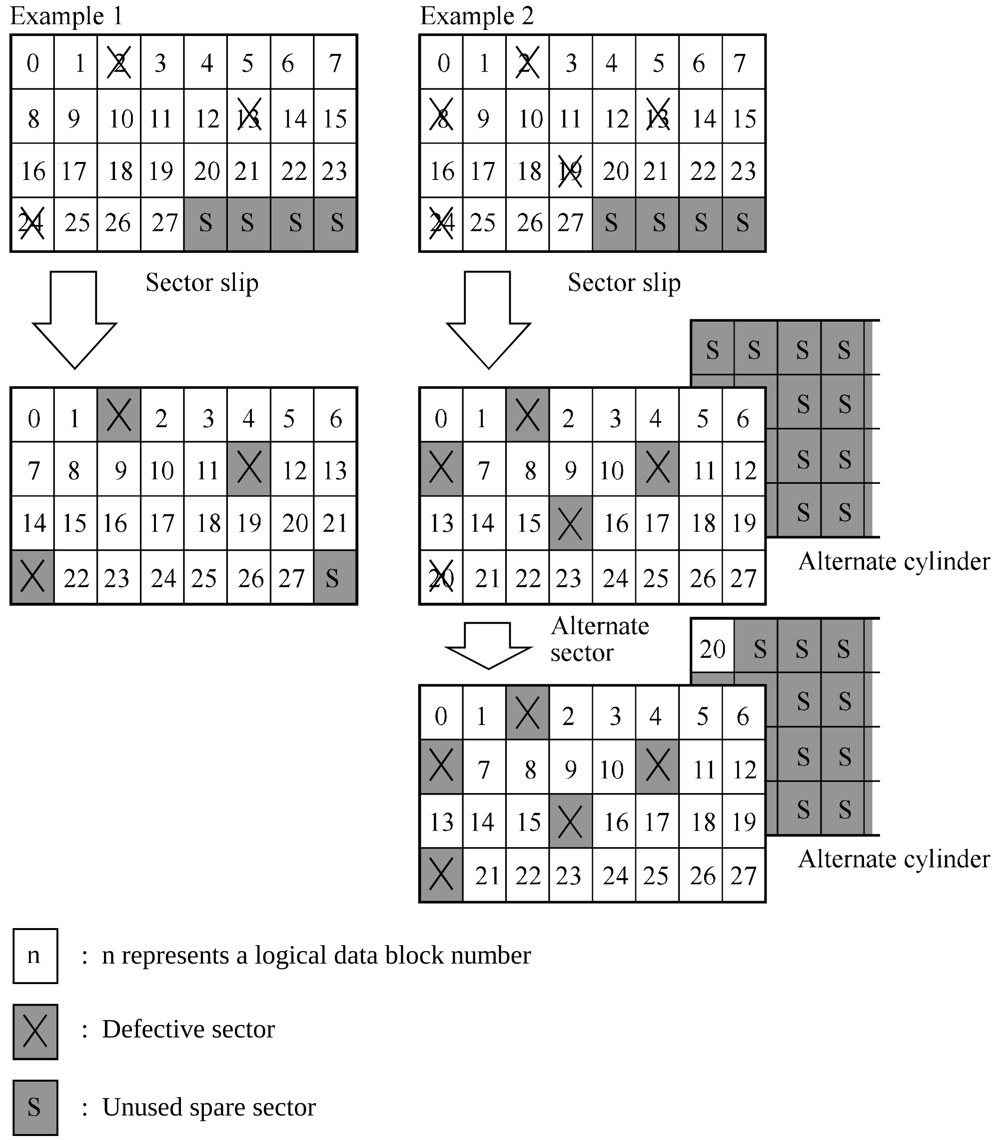


Figure 3.7 Alternate block allocation by FORMAT UNIT command

During FORMAT UNIT command, alternate block allocation is conducted in following cases:

1) Unrecovered write offtrack condition during a media write

2) Uncorrectable Data Error during a media read (certification) *1

If above errors are detected during FORMAT UNIT command, the IDD allocates the alternate block(s) to the defective data blocks. Reassign procedure itself is the same as one in REASSIGN BLOCKS command.

*1. Certification is permitted when DCRT flag is cleared (DCRT flag=0) in FORMAT UNIT command.
The IDD checks all initialized logical data blocks by reading them out after the above alternate block allocation is made to initialize (format) the disk.

(2) Alternate block allocation by REASSIGN BLOCKS command

When the REASSIGN BLOCKS command is specified, the alternate block is allocated to the defective logical data block specified by the initiator by means of alternate sector treatment. The alternate block is allocated to unused spare sectors in the alternate cylinder.

Figure 3.8 is examples of the alternate block allocation by the REASSIGN BLOCKS command.

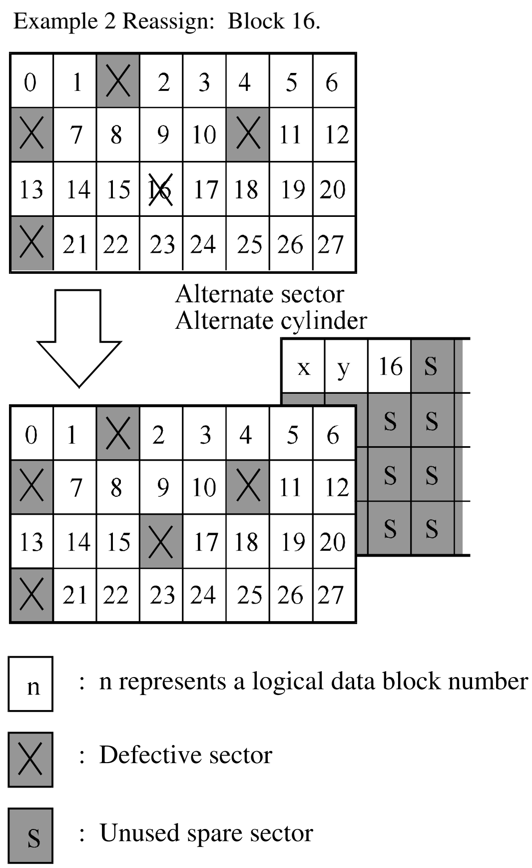


Figure 3.8 Alternate block allocation by REASSIGN BLOCKS command

(3) Automatic alternate block allocation

- Automatic alternate block allocation at read operation

If the ARRE flag in the MODE SELECT parameter permits the automatic alternate block allocation, the IDD automatically executes the alternate block allocation and data duplication on the defective data block detected during the READ or READ EXTENDED command. This allocation method is the same as with the REASSIGN BLOCKS command (alternate sector treatment).

- Automatic alternate block allocation at write operation

If AWRE flag in the MODE SELECT parameter permits the automatic alternate block allocation, the IDD executes two kinds of automatic alternate processing during WRITE command processing as described below:

Type 1 (Reassignment of Uncorrectable Read Error)

1) Commands to be applied
   - WRITE
   - WRITE EXTEND
   - WRITE at executing WRITE AND VERIFY
2) Application requirements
   When any of the above commands is issued to LBA registered in the uncorrectable error log of the READ command (LBA log of uncorrectable error while the READ command is executed), the AWRE processing is applied.
3) AWRE processing
   The following processings are performed when the LBA matches the one in the uncorrectable error log:
   a) Primary media check
      - Creates an uncorrectable error pattern (invalid LBA pattern) in the position of the error LBA, repeats the primary media check up to three times. If the error still occurs after the check repeated three times, it is judged to be defective. Then, it performs the alternate processing.
   b) Alternate processing
      - Alternate media check
        Writes the data that causes an unrecoverable error into the alternate block, and performs the media check.
        (If the alternate block is a defective sector, the block is registered to the G list, another alternate block is allocated.)
   c) SA and defect map update processing (on alternate side)

When an error occurs in the alternate processing, this WRITE command terminates with error.

When the alternate processing normally terminates, the WRITE command is executed.

Depending on the alternate processing result, one of the following additional sense codes is returned:

Alternate processing is succeeded: 01-OC-01

Type 2 (Reassignment of write fail sector)

1) Commands to be applied
   - WRITE command
   - WRITE EXTENDED command
   - FORMAT UNIT

2) Application requirements / processing
   When WRITE/WRITE EXTENDED command detects any Servo error (e.g. Write offtrack error) and cannot be recovered within pre-determined retry number (specified in Mode Parameter). For the sectors around defective Servo, alternate blocks are allocated and the data of this WRITE commands are re-written.

Sectors to be made AWRE shall be following:

- the sector where the error occurs and the latter sectors and,
- the sectors whose data are logically continual and stored in Cache,
- the sectors which will be processed in this Write command and,
- the sectors which locate between erroneous Servo −1 and +1 (including Split sector)

This function is also applied for the sector that has already been re-assigned.

Remark:

When a write protection is prohibited through the setting terminal, the auto alternate block allocation processing specification is disabled.

IMPORTANT

Automatic alternate block allocation is made only once during the execution of one command. If second defective block is detected, the alternate block assignment processing for the first defective block is executed but the alternate block assignment processing for the second one is not executed and the command being executed terminates. However, the initiator can recover the twice error by issuing the same command again.

When an error is detected in a data block in the data area, recovery data is rewritten and verified in automatic alternate block allocation during the execution of the READ or READ EXTENDED command. Alternate block allocation will not be made for the data block if recovery is successful.

Example: Even if the data error which is recoverable by the WRITE LONG command is simulated, automatic alternate block allocation will not be made for the data block.

CHAPTER 4 INSTALLATION REQUIREMENTS

This chapter describes the environmental, mounting, power supply, and connection requirements.

4.1 Mounting Requirements

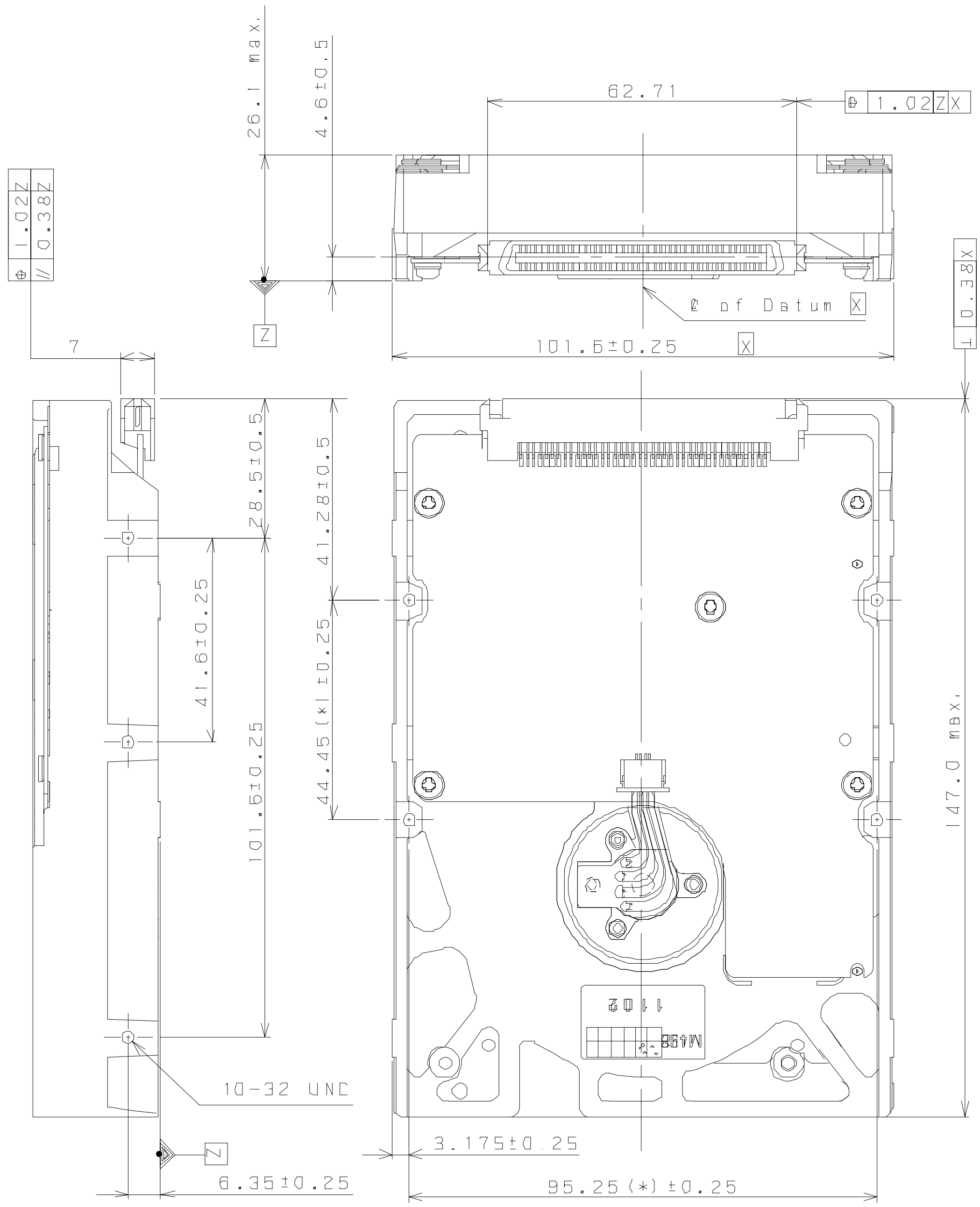
4.1.1 External dimensions

Figures 4.1 and 4.2 show the external dimensions of the IDD and the locations of the holes for the IDD mounting screws.

Dimensions are in mm.

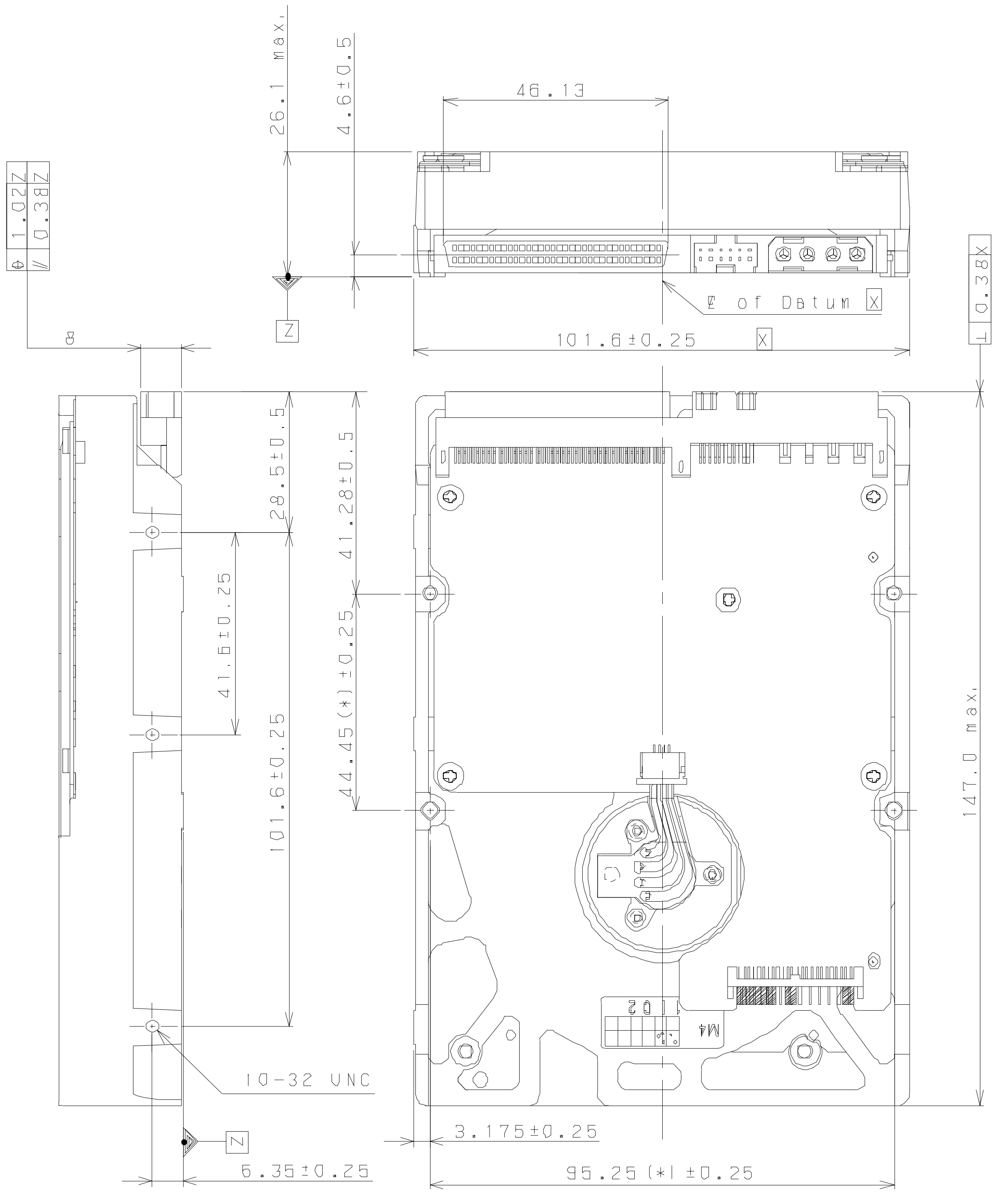
Note:

Mounting screw: #6-32UNC



The value marked with (*) indicates the dimension between mounting holes on the bottom face.

Figure 4.1 NC external dimensions



The value marked with (*) indicates the dimension between mounting holes on the bottom face.

Figure 4.2 NP external dimensions

4.1.2 Mounting

The permissible orientations of the IDD are shown in Figure 4.3, and the tolerance of the angle is ±5° from the horizontal plane.

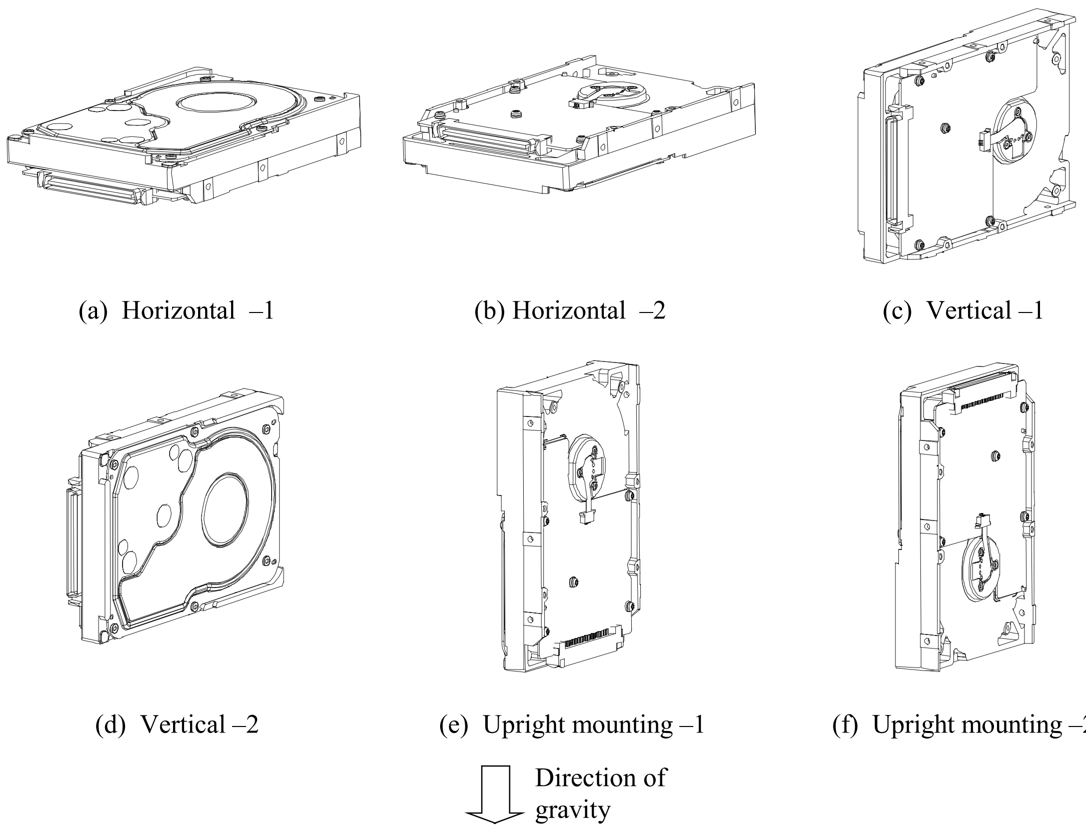


Figure 4.3 IDD orientations

(1) Mounting frame structure

Special attention must be given to mount the IDD disk enclosure (DE) as follows.

a) Use the frame with an embossed structure, or the like. Mount the IDD with making a gap of 2.5 mm or more between the IDD and the frame of the system.

b) As shown in Figure 4.4, the inward projection of the screw from the IDD frame wall at the corner must be 5.0 mm or less.

c) Tightening torque of screw must be secured with 0.59N·m (6kgf·cm) ±12%.

d) Impact caused by the electric driver must be within the device specifications.

e) Must be handled on an anti-static mat.

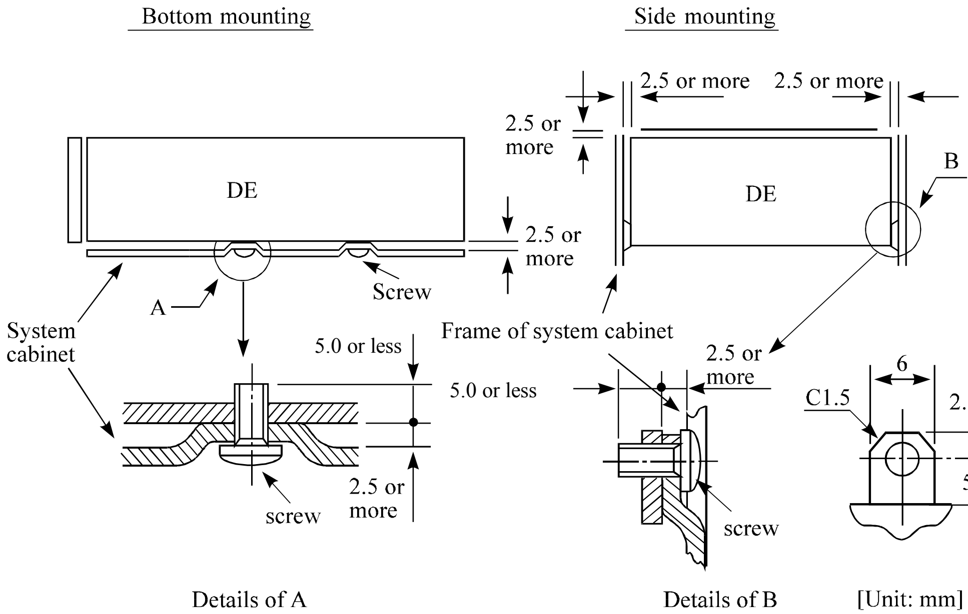


Figure 4.4 Mounting frame structure

(2) Limitation of side-mounting

Mount the IDD using the 4 screw holes at the both ends on the both sides as shown in Figure 4.5. Do not use the center hole by itself.

In case of using the center hole, it must be used in combination with 2 holes on both ends. (Total 6 screws for 6 holes enclosed)

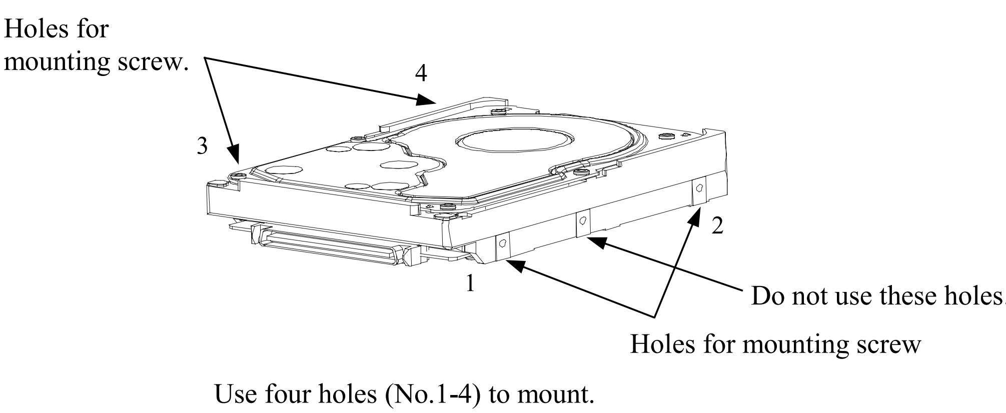


Figure 4.5 Limitation of side-mounting

(3) Limitation of bottom-mounting

Use all 4 mounting holes on the bottom face.

(4) Environmental temperature

Temperature condition at installed in a cabinet is indicated with ambient temperature measured 30 mm from the disk drive. At designing the system cabinet, consider following points.

- Make a suitable air flow so that the DE surface temperature does not exceed 60°C.
- Cool the PCA side especially with air circulation inside the cabinet. Confirm the cooling effect by measuring temperature of specific ICs and the DE. These measurement results should be within a criteria listed in Table 4.1.

Table 4.1 Surface temperature check point

No.	Measurement point	Criteria
1	Center of DE cover	60°C
2	Read channel LSI	88°C
3	VCM/SPM Driver	92°C
4	HDC	91°C
5	MPU	91°C

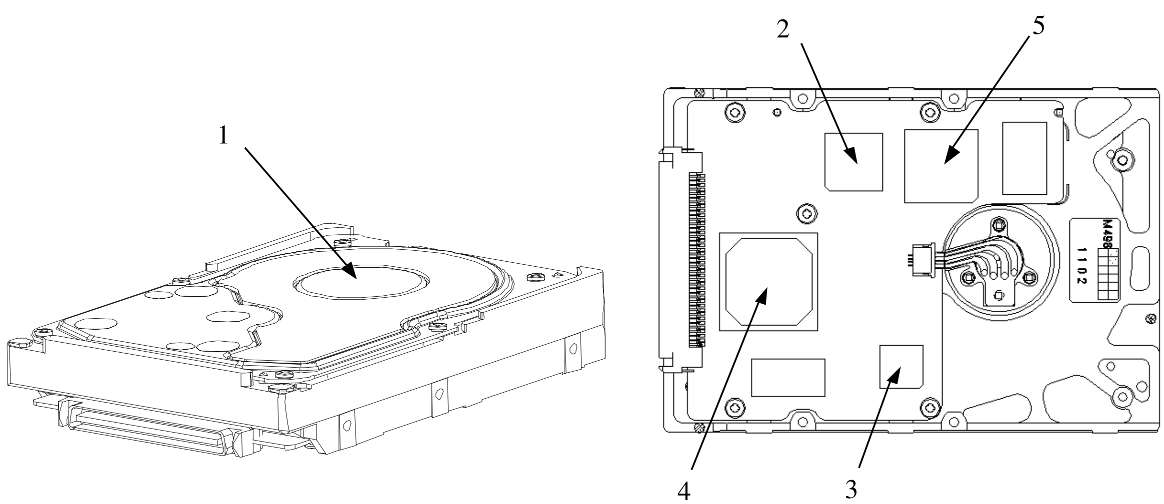


Figure 4.6 Surface temperature measurement points

(5) Service clearance area

The service clearance area, or the sides which must allow access to the IDD for installation or maintenance, is shown in Figure 4.7.

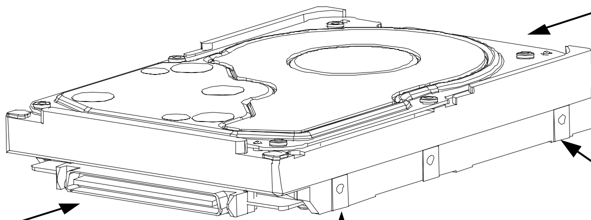


Figure 4.7 Service clearance area

(6) External magnetic field

The drive should not be installed near the ferromagnetic body like a speaker to avoid the influence of the external magnetic field.

(7) Leak magnetic flux

The IDD uses a high performance magnet to achieve a high speed seek. Therefore, a leak magnetic flux at surface of the IDD is large. Mount the IDD so that the leak magnetic flux does not affect to near equipment.

(8) Others

Seals on the DE prevent the DE inside from the particle. Do not damage or peel off labels.

4.2 Power Supply Requirements

(1) Allowable input voltage and current

The power supply input voltage measured at the power supply connector pin of the IDD (receiving end) must satisfy the requirement given in Subsection 2.1.3. (For other requirements, see Items (4) and (5) below.)

(2) Current waveform (reference)

Figure 4.8 shows the spin-up current waveform of +12 VDC.

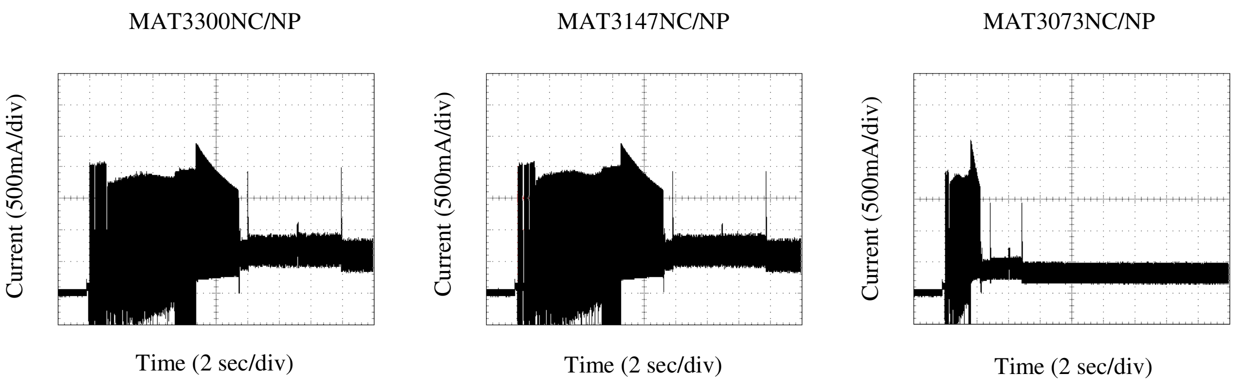


Figure 4.8 Spin-up current waveform (+12 VDC)

(3) Power on/off sequence

a) The order of the power on/off sequence of +5 VDC and +12 VDC, supplied to the IDD, does not matter.

b) In a system which uses the terminating resistor power supply signal (TERMPWR) on the SCSI bus, the requirements for +5 VDC given in Figure 4.9 must be satisfied between the IDD and at least one of the SCSI devices supplying power to that signal.

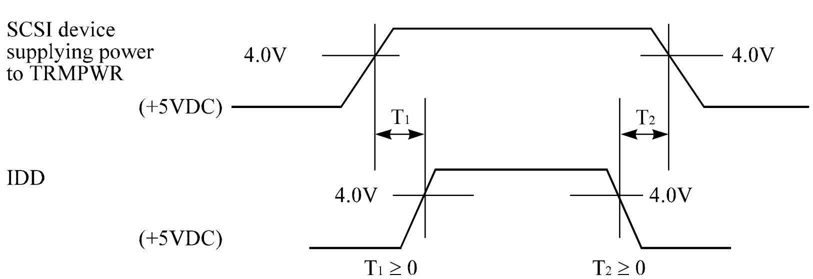


Figure 4.9 Power on/off sequence (1)

c) In a system which does not use the terminating resistor power supply signal (TERMPWR) on the SCSI bus, the requirements for +5 VDC given in Figure 4.10 must be satisfied between the IDD and the SCSI device with the terminating resistor circuit.

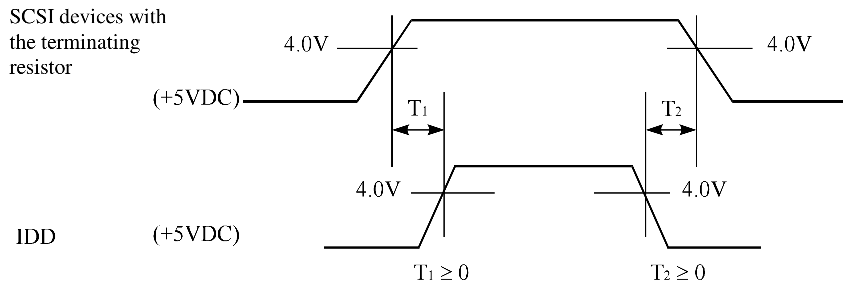


Figure 4.10 Power on/off sequence (2)

d) Between the IDD and other SCSI devices on the SCSI bus, the +5 VDC power on/off sequence is as follows:

- In a system with its all SCSI devices designed to prevent noise from leaking to the SCSI bus when power is turned on or off, the power sequence does not matter if the requirement in b) or c) is satisfied.

- In a system containing an SCSI device which is not designed to prevent noise from leaking to the SCSI bus, the requirement given in Figure 4.11 must be satisfied between that SCSI device and the IDD.

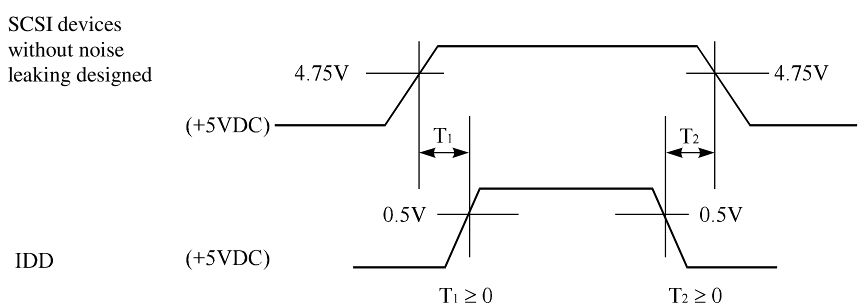


Figure 4.11 Power on/off sequence (3)

(4) Sequential starting of spindle motors

After power is turned on to the IDD, a large amount of current flows in the +12 VDC line when the spindle motor rotation starts. Therefore, if more than one IDD is used, the spindle motors should be started by the following procedures to prevent overload of the power supply unit. Regarding how to set a spindle motor start control mode, see Subsection 5.3.2.

For the NP model drives, the spindle motors should be started sequentially using of the following procedures.

a) Issue START/STOP commands at more than 12-second intervals to start the spindle motors. For details of this command specification, refer to SCSI Logical Interface Specifications.

b) Turn on the +12 VDC power in the power supply unit at more than 12-second intervals to start the spindle motors sequentially.

For the NC model drives, the spindle motors should be started after a delay of 12 seconds times [SCSI ID] by setting CN1-38 pin to open and CN1-78 pin to short.

SCSI ID	Delay time of spindle motor starting
0	0
1	12 s
2	24 s
⋮	⋮
15	180 s

(5) Power supply to SCSI terminating resistor

If power for the terminating resistor is supplied from the IDD to other SCSI devices through the SCSI bus, the current-carrying capacity of the +5 VDC power supply line to the IDD must be designed with considering of an increase of up to 200 mA.

A method of power supply to the terminating resistor is selected with a setting terminal on the IDD (NP model only). See Subsection 5.3.2 for this selection.

For the electrical condition of supplying power to the terminating resistor, refer to Subsection 1.4.2 in SCSI Physical Interface Specifications.

(6) Noise filter

To eliminate AC line noise, a noise filter should be installed at the AC input terminal on the IDD power supply unit. The specification of this noise filter is as follows:

- Attenuation: 40 dB or more at 10 MHz
- Circuit construction: T-configuration as shown in Figure 4.12 is recommended.

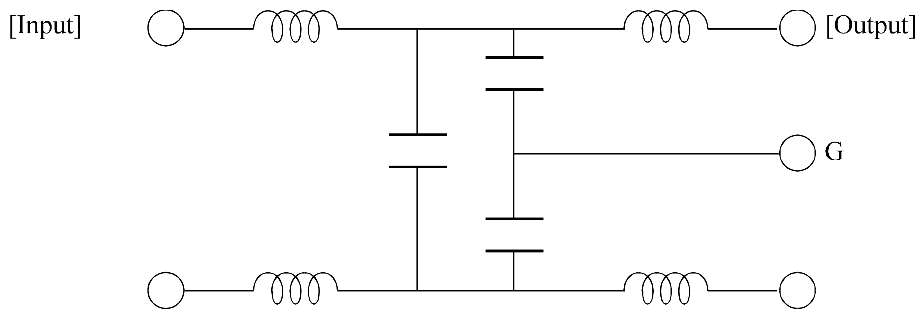


Figure 4.12 AC noise filter (recommended)

4.3 Connection Requirements

4.3.1 SCA2 connector type 16-bit SCSI model (NC model)

(1) Connectors

Figure 4.13 shows the locations of connectors on the SCA2 connector type 16-bit SCSI model (NC model).

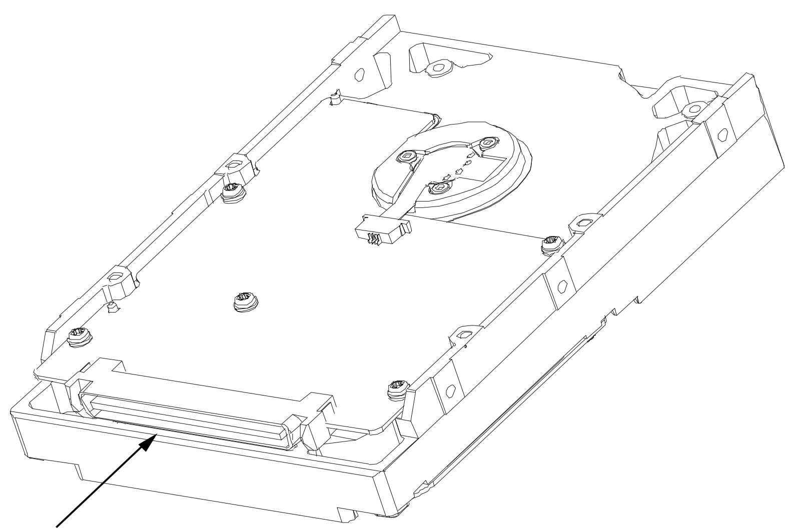


Figure 4.13 NC connectors location

(2) SCSI connector and power supply connector

The connector for the SCSI bus is an unshielded SCA-2 connector conforming to SCSI-3 type which has two 40-pin rows spaced 1.27 mm (0.05 inch) apart. The power connector is included in the SCSI connector.

Figure 4.14 shows the SCSI connector. See Section B.1 in Appendix B for signal assignments on the connector.

For details on the physical/electrical requirements of the interface signals, refer to Sections 1.3 and 1.4 in SCSI Physical Interface Specifications.

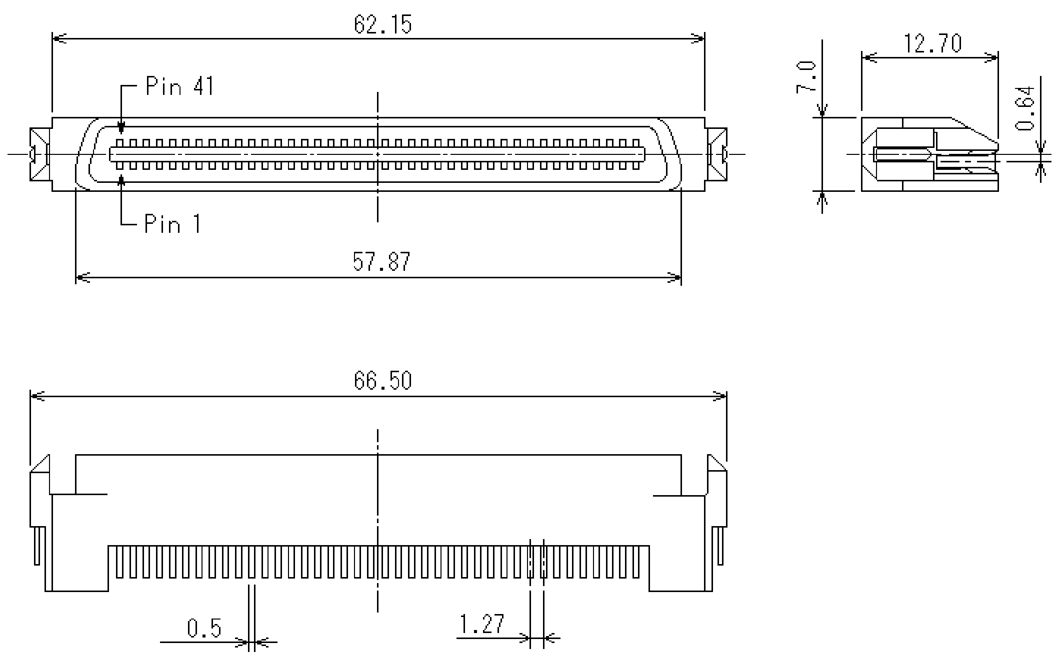


Figure 4.14 SCA2 type 16-bit SCSI connector

(3) Connector for external operator panel

This connector is not available for NC model drives.

4.3.2 68 pin connector type 16-bit SCSI model (NP model)

(1) Connectors

Figures 4.15 show the locations of connectors and terminals on the 68 pin connector type 16-bit SCSI model (NP model).

- Power supply connector
- SCSI connector
- External operator panel connector

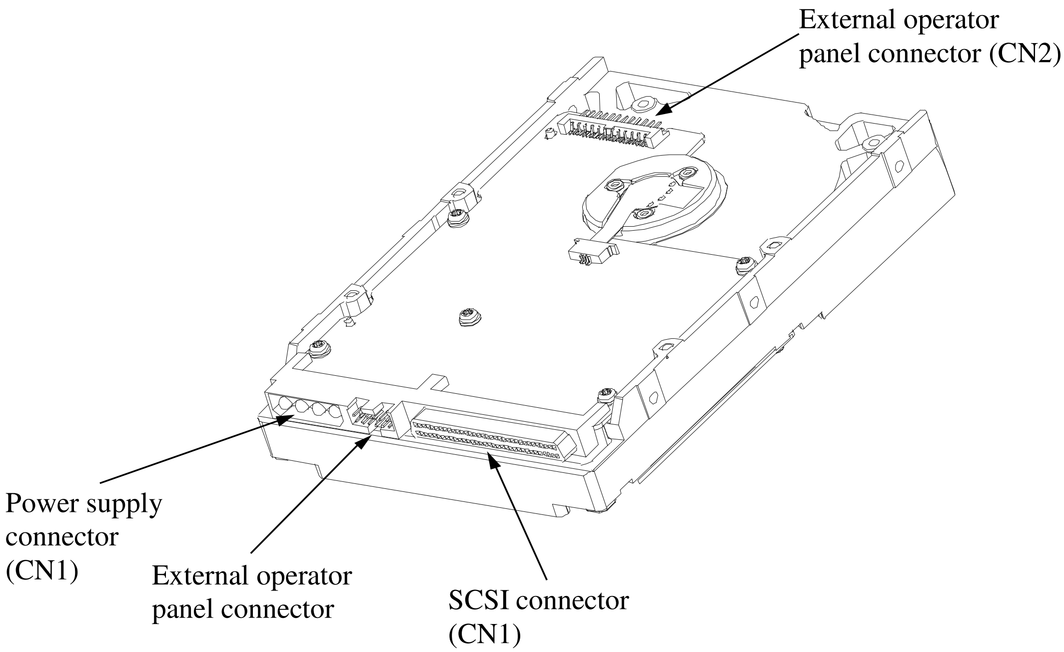


Figure 4.15 NP connectors and terminals location

(2) SCSI connector and power supply connector

a. 16-bit SCSI

The connector for the SCSI bus is an unshielded P connector conforming to SCSI-3 type which has two 34-pin rows spaced 1.27 mm (0.05 inch) apart. Figure 4.16 shows the SCSI connector. See Section B.2 in Appendix B for the signal assignments on the SCSI connector.

For details on the physical/electrical requirements of the interface signals, refer to Sections 1.3 and 1.4 in the SCSI Physical Interface Specifications.

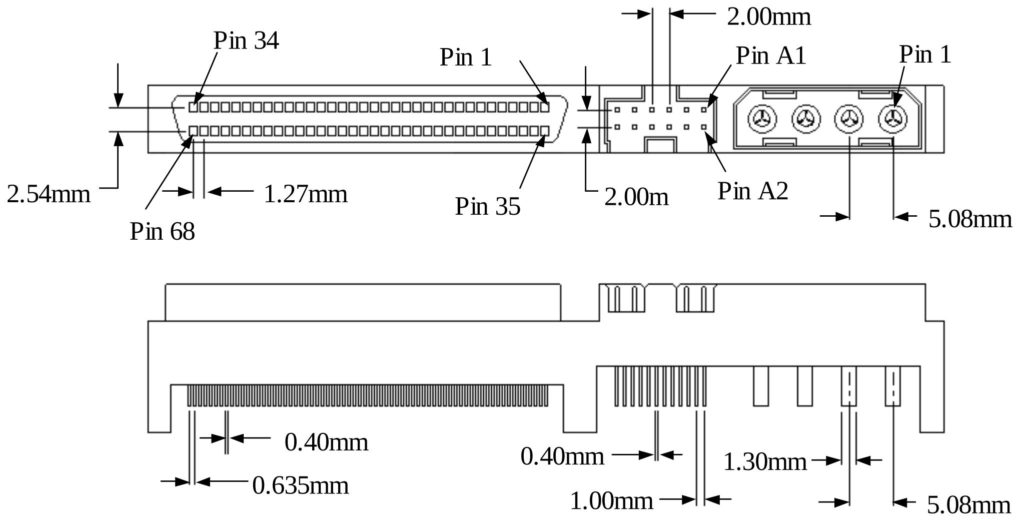
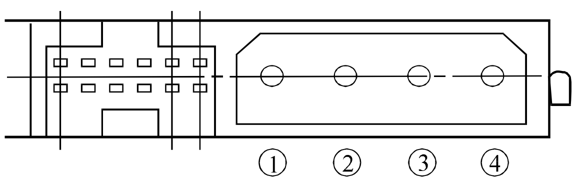


Figure 4.16 68 pin type 16-bit SCSI interface connector

b. Power supply connector

Figure 4.17 shows the shape and the terminal arrangement of the output connector of DC power supply.



①	+12 VDC
②	+12 VDC RETURN (GND)
③	+5 VDC RETURN (GND)
④	+5 VDC

Figure 4.17 Power supply connector (68 pin type 16-bit SCSI)

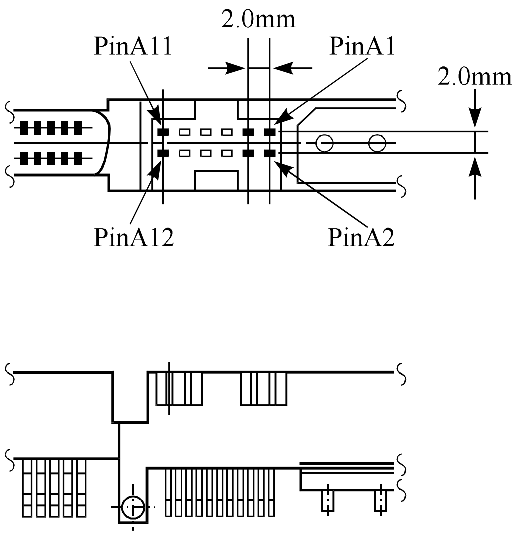
(3) SG terminal

The IDD is not provided with an SG terminal (fasten tab) for DC grounding. Therefore, when connecting SG and FG in the system, use the +5 VDC RETURN (ground) inside the power supply connector as the SG on the power supply side.

(4) Connector for external operator panel

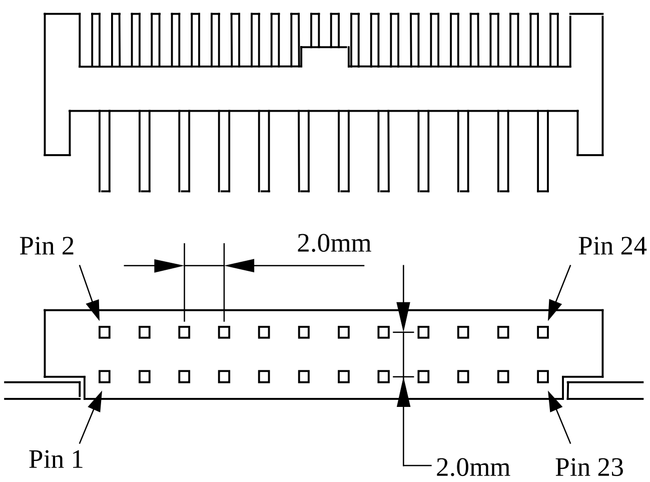
- Connector for 16-bit SCSI external operator panel

CN1 provides connector for the external operator panel other than the SCSI bus as shown in Figure 4.18. Also, a connector for the external operator panel are provided on the IDD as shown in Figure 4.19. This allows connection of an external LED on the front panel, and an SCSI ID setting switch. For the recommended circuit of the external operator panel, see Subsection 4.3.4.



Pin	Signal
A1	–ID0
A2	Fault LED
A3	–ID1
A4	ESID
A5	–ID2
A6	(Reserved)
A7	–ID3
A8	–LED
A9	OPEN
A10	GND
A11	+5 V
A12	–WTP

Figure 4.18 External operator panel connector (CN1)



CN2

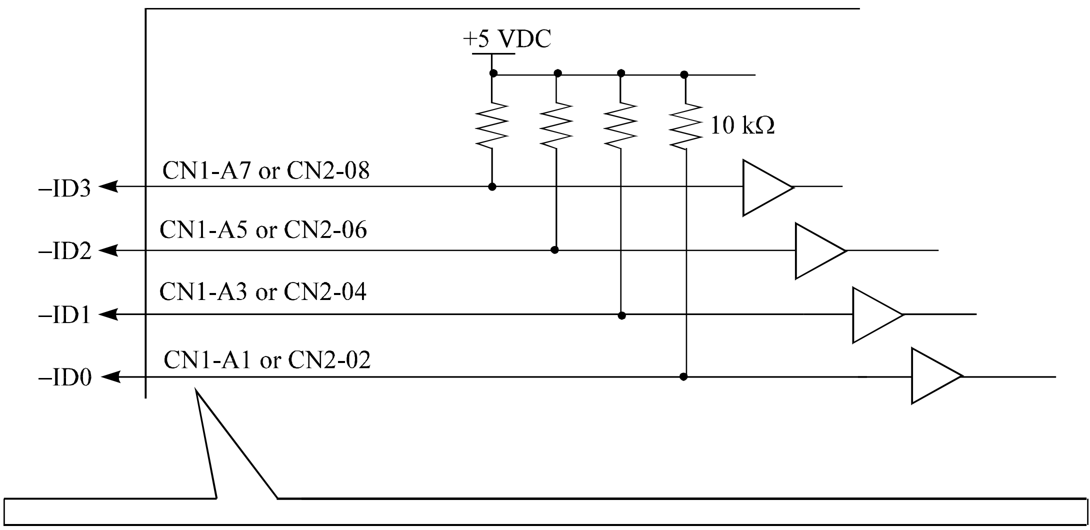
Pin	Signal	Pin	Signal
01	GND	02	-ID0
03	GND	04	-ID1
05	GND	06	-ID2
07	GND	08	-ID3
09	GND	10	-WTP
11	GND	12	RMSTART
13	GND	14	8/16 SW
15	GND	16	DIFFSENS
17	GND	18	N.C.
19	N.C.	20	RESET
21	LED (+5V)	22	-LED
23	TRMPOW	24	TRMPOW

Figure 4.19 External operator panel connector (CN2)

(5) External operator panel connector Signals

a. 16-bit SCSI –ID3, –ID2, –ID1, –ID0: Input signals (CN1-A1, A3, A5, A7 pin and CN2-02, 04, 06, 08 pin)

These signals are used for providing switches to set the SCSI ID of the IDD externally. Figure 4.20 shows the electrical requirements. For the recommended circuit examples, see Subsection 4.3.4.

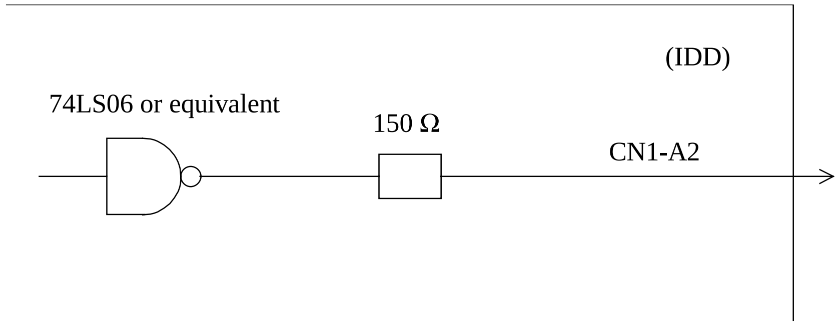


Input level				SCSI ID
–ID3	–ID2	–ID1	–ID0	
0 to 0.4 VDC	0 to 0.4 VDC	0 to 0.4 VDC	0 to 0.4 VDC	15
0 to 0.4 VDC	0 to 0.4 VDC	0 to 0.4 VDC	(Open)	14
0 to 0.4 VDC	0 to 0.4 VDC	(Open)	0 to 0.4 VDC	13
0 to 0.4 VDC	0 to 0.4 VDC	(Open)	(Open)	12
0 to 0.4 VDC	(Open)	0 to 0.4 VDC	0 to 0.4 VDC	11
0 to 0.4 VDC	(Open)	0 to 0.4 VDC	(Open)	10
0 to 0.4 VDC	(Open)	(Open)	0 to 0.4 VDC	9
0 to 0.4 VDC	(Open)	(Open)	(Open)	8
(Open)	0 to 0.4 VDC	0 to 0.4 VDC	0 to 0.4 VDC	7
(Open)	0 to 0.4 VDC	0 to 0.4 VDC	(Open)	6
(Open)	0 to 0.4 VDC	(Open)	0 to 0.4 VDC	5
(Open)	0 to 0.4 VDC	(Open)	(Open)	4
(Open)	(Open)	0 to 0.4 VDC	0 to 0.4 VDC	3
(Open)	(Open)	0 to 0.4 VDC	(Open)	2
(Open)	(Open)	(Open)	0 to 0.4 VDC	1
(Open)	(Open)	(Open)	(Open)	0

Figure 4.20 16-bit SCSI ID external input

b. Fault LED: Output signal (CN1-A2 pin)

The IDD indicates that the write-protect status is in effect (CN1-A12 is connected to the GND, or the CN2-9 and CN2-10 are short-circuited.) A signal for driving the LED is output.



IMPORTANT

This signal is temporarily driven at the GND level when the micro program reads the SCSI ID immediately after the power supply to the IDD has been switched on (it is possible to set up the SCSI ID by short circuiting CN1-A1 and CN1-A2.)

c. CN1-A6 (reserved)

This pin is temporarily driven at the GND level when the micro program reads the SCSI ID immediately after the power supply to the IDD has been switched on (it is possible to set up the SCSI ID by short circuiting CN1-A3 and CN1-A4, and CN1-A5 and CN1-A6.)

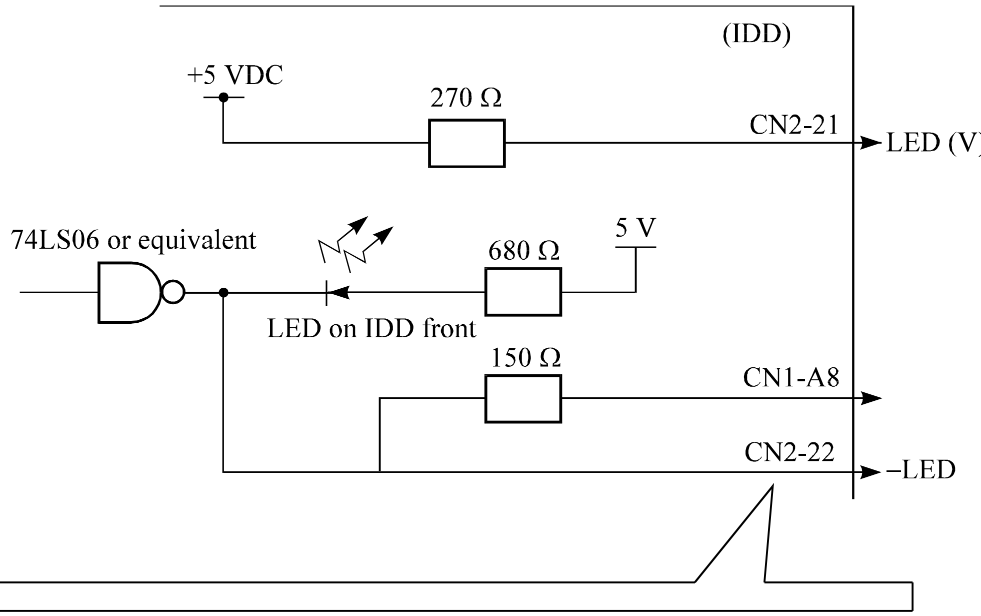
This pin gets high impedance status except above.

d. –LED and LED (+5V): Output signals (CN1-A8 pin and CN2-21, 22 pin)

These signals drive the external LED as same as LED on the front of the disk drive. The electrical requirements are given in Figure 4.21.

IMPORTANT

1. *The external LED is identical in indication to the LED on the front of the IDD.*
2. *Any load other than the external LED (see Subsection 4.3.5) should not be connected to the CN2-21, 22 pin (LED [V] and –LED terminals).*
3. *This signal is temporarily driven at the GND level when the micro program reads the SCSI ID immediately after the power supply to the IDD has been switched on (it is possible to set up the SCSI ID by short circuiting CN1-A7 and CN1-A8.)*



Output level	Function
0 to 0.4 VDC (I_{OL} = 15mA max.)	LED on
2.5 to 5.25 VDC	LED off

Figure 4.21 Output signal for external LED

e. –WTP: Input signal (CN1-A12 and CN2-9, 10 pin)

By connecting the CN1-A12 and CN2-10 pins to the GND, writing operations into the IDD disc media are set to disable.

(6) Cable connection requirements

The requirements for cable connection between the IDD, host system, and power supply unit are given in Figure 4.22. Recommended components for connection are listed in Table 4.2.

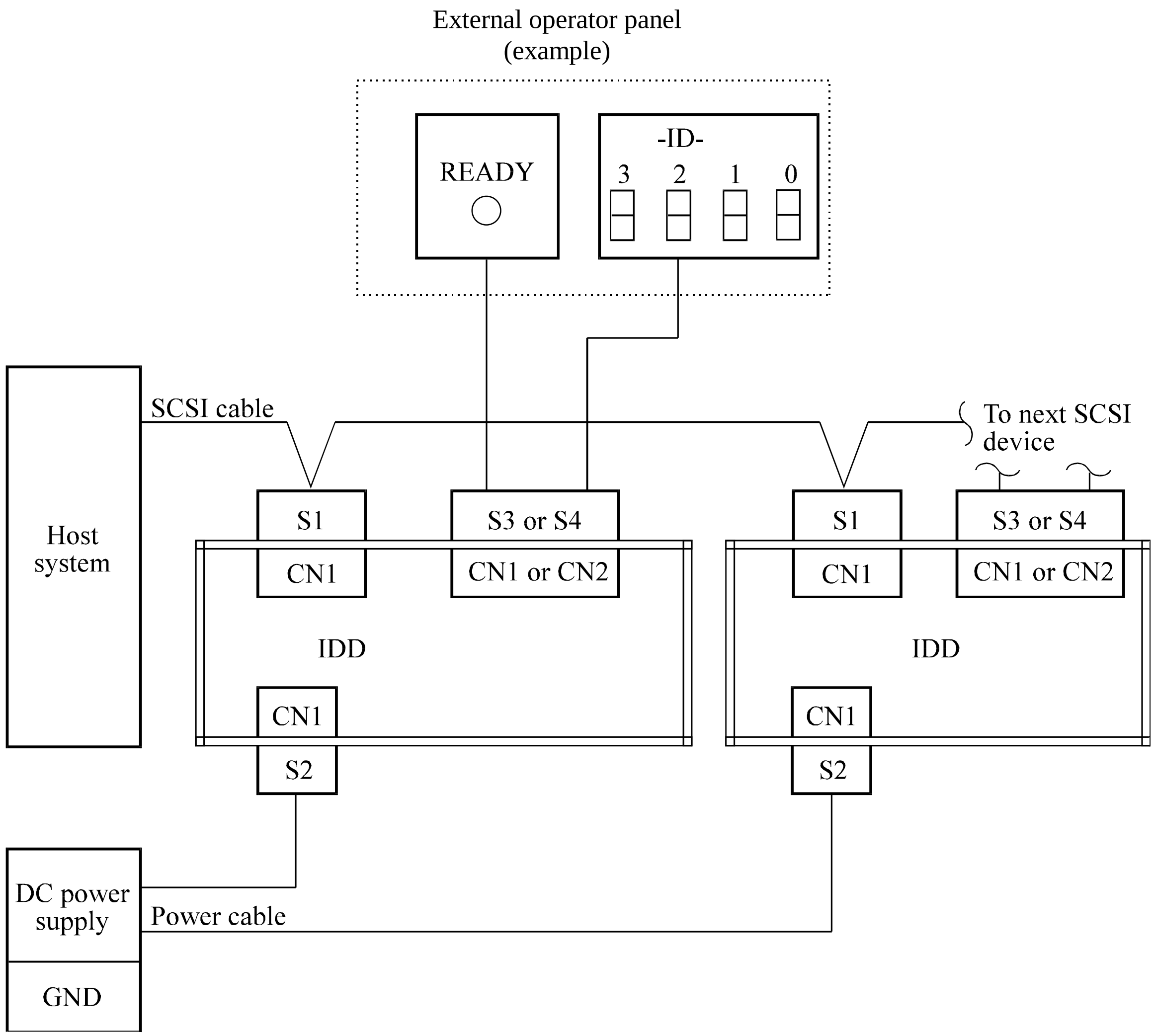


Figure 4.22 SCSI cables connection

4.3.3 Cable connector requirements

Table 4.2 lists the recommended components cable connection.

Table 4.2 Recommended components for connection

Applicable model		Name	Par number (Size)	Manufacturer	Reference (*1)
NC	SCSI connector (CN1)	Connector	787311-1	Tyco Electronics AMP	
			87689-0001	Molex	
NP	SCSI cable (CN1)	Cable socket (closed-end type)	DHJ-PAC68-2AN	DDK	S1
			786090-7	Tyco Electronics AMP	
		Signal cable	UL20528-FRX-68-P0.635	Fujikura	
	Power supply cable (CN1)	Cable socket housing	1-480424-0	Tyco Electronics AMP	S2
		Contact	170148-1	Tyco Electronics AMP	
		Cable	(AWG18 to 24)		
	External operator panel (CN1)	Cable socket housing	A3B-12D-2C	HIROSE ELECTRIC	S3
		Contact	A3B-2630SCC	HIROSE ELECTRIC	
		Cable	(AWG26 to 36)		
	External operator panel (CN2)	Cable socket housing	FCN-723J024/2M	FUJITSU TAKAMIZAWA	S4
		Contact	FCN-723J-G/AM	FUJITSU TAKAMIZAWA	
		Cable	(AWG28)		

(*1) See Figure 4.22.

(1) SCSI cable

See Section 1.3, “Physical Requirements”, and Section 1.4, “Electrical Requirements”, in SCSI Physical Interface Specifications.

(2) Power cable

IDDs must be star-connected to the DC power supply (one to one connection) to reduce the influence of load variations.

(3) DC ground

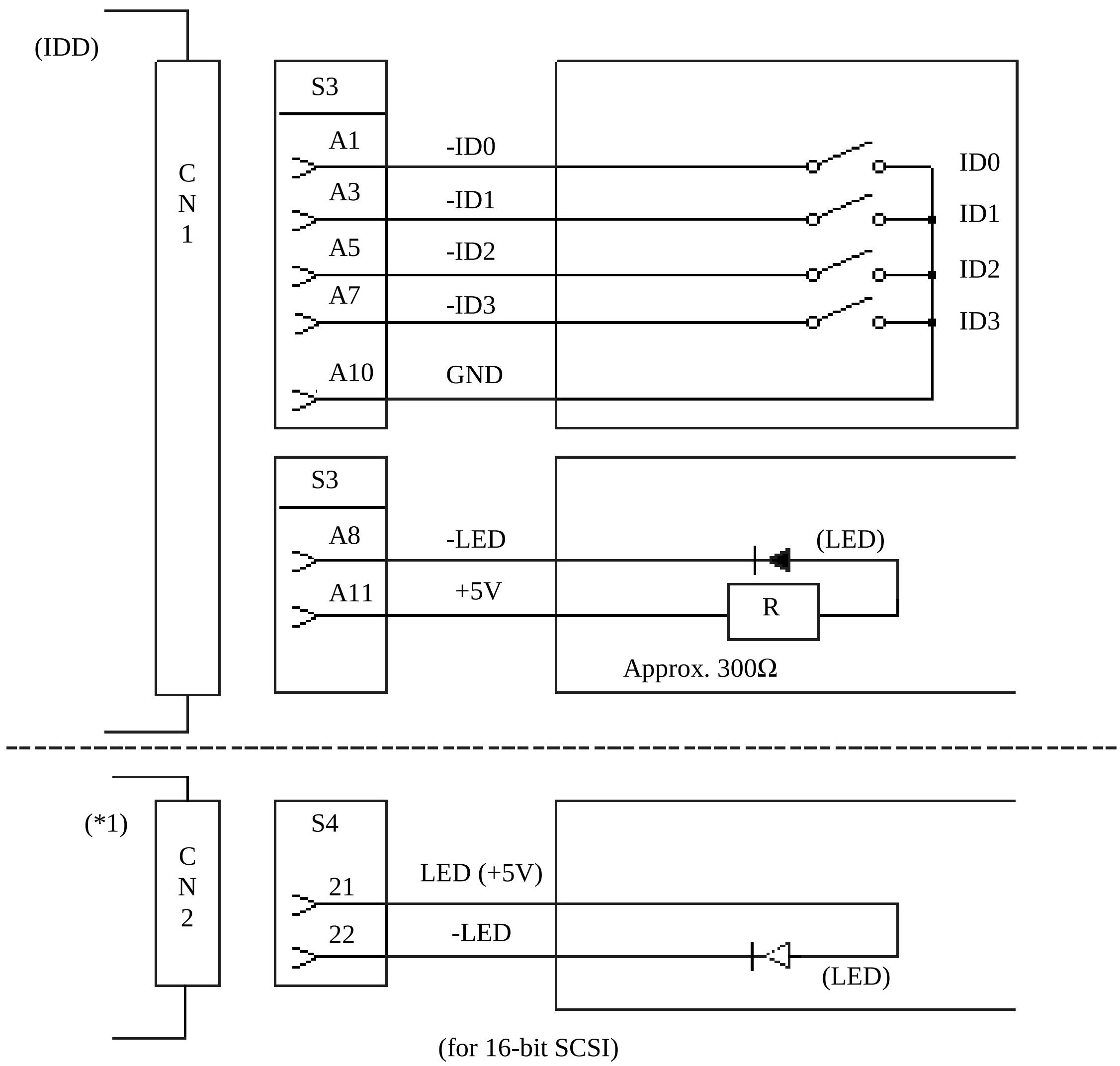
The DC ground cable must always be connected to the IDD because no fasten tab dedicated to SG is provided with the IDD. Therefore, when SG and FG are connected in the system, it is necessary to connect SG and FG at the power supply or to connect SG of the power supply to FG of the system.

(4) External operator panel (NP model only)

The external operator panel is installed only when required for the system. When connection is not required, leave open the following pins in the external operator panel connector of the IDD : Pins 21, 22 and pins 01 through 08 in CN2 and pins A1 through A12 in CN1.

4.3.4 External operator panel (on NP model drives only)

A recommended circuit of the external operator panel is shown in Figure 4.23. Since the external operator panel is not provided as an option, this panel must be fabricated at the user site referring to the recommendation if necessary.



(*1) For connecting the external LED to CN2.

Figure 4.23 External operator panel circuit example

IMPORTANT

Do not connect the external LED to both CN1 and CN2. Connect it to either of them.

CHAPTER 5 INSTALLATION

This chapter describes the notes on handling drives, connections, setting switches and plugs, mounting drives, connecting cables, confirming drive operations after installation and preparation for use, and dismounting drives.

5.1 Notes on Handling Drives

The items listed in the specifications in Table 2.1 must be strictly observed.

(1) General notes

a) Do not give the drive shocks or vibrations exceeding the value defined in the standard because it may cause critical damage to the drive. Especially be careful when unpacking.

b) Do not leave the drive in a dirty or contaminated environment.

c) Since static discharge may destroy the CMOS semiconductors in the drive, note the following after unpacking:

- Use an ESD strap and body grounding when handling the drive.
- Do not touch any components on the PCAs except setting terminal (CN1 and CN2).

⚠ CAUTION

Hot temperature
To prevent injury, do not handle the drive until after the device has cooled sufficiently after turning off the power. The DE and LSI become hot during operation and remain hot immediately after turning off the power.

(2) Unpackaging

a) Use a flat work area. Check that the "This Side Up" sign side is up. Handle the package on soft material such as a rubber mat, not on hard material such as a wooden desk.

b) Be careful not to give excess pressure to the internal unit when removing cushions.

c) Be careful not to give excess pressure to the PCAs and interface connector when removing the drive from the Fcell.

d) Do not remove the sealing label or cover of the DE and screws.

(3) Installation/removal/replacement

a) Do not attempt to connect or disconnect connections when power is on. The only pin settings that may be altered are pins 9, 10 (Write Protect) in CN2. (NP model)

b) Do not move the drive when power is turned on or until the drive completely stops (for 30 seconds) after power is turned off.

c) Place and keep removed screws and other parts where they will not get lost or damaged.

d) Keep a record of all maintenance work for replacing.

(4) Packaging

a) Store the drive in an antistatic case (Fcell).

b) It is recommended to use the same cushions and packages as those at delivery. If those at delivery cannot be used, use a package with shock absorption so that the drive is free from direct shocks. In this case, fully protect the PCAs and interface connector so that they are not damaged.

(5) Delivery

a) When delivering the drive, provide packaging and do not turn it over.

b) Minimize the delivery distance after unpacking and avoid shocks and vibrations with cushions. For the carrying direction at delivery, use one of the mount allowable directions in Subsection 4.2.2 (vertical direction is recommended).

(6) Storage

a) Provide moistureproof packaging for storage.

b) The storage environment must satisfy the requirements specified in Subsection 2.1.3 when the drive is not operating.

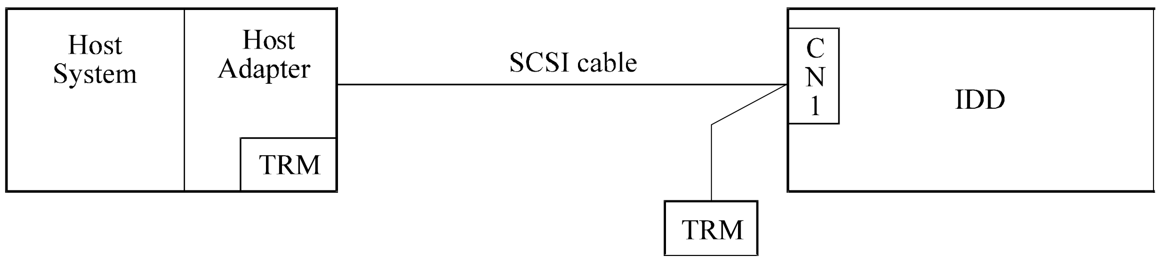
c) To prevent condensation, avoid sudden changes in temperature.

5.2 Connections

Figure 5.1 shows examples of connection modes between the host system and the IDD. For the 16-bit SCSI, up to 16 devices including the host adapter, IDD, and other SCSI devices can be connected to the SCSI bus in arbitrary combinations. Install a terminating resistor on the SCSI device connected to both ends of the SCSI cable.

See Section 4.4 for the cable connection requirements and power cable connections.

(1) Connecting one IDD



(2) Connecting more than one IDD (single host)

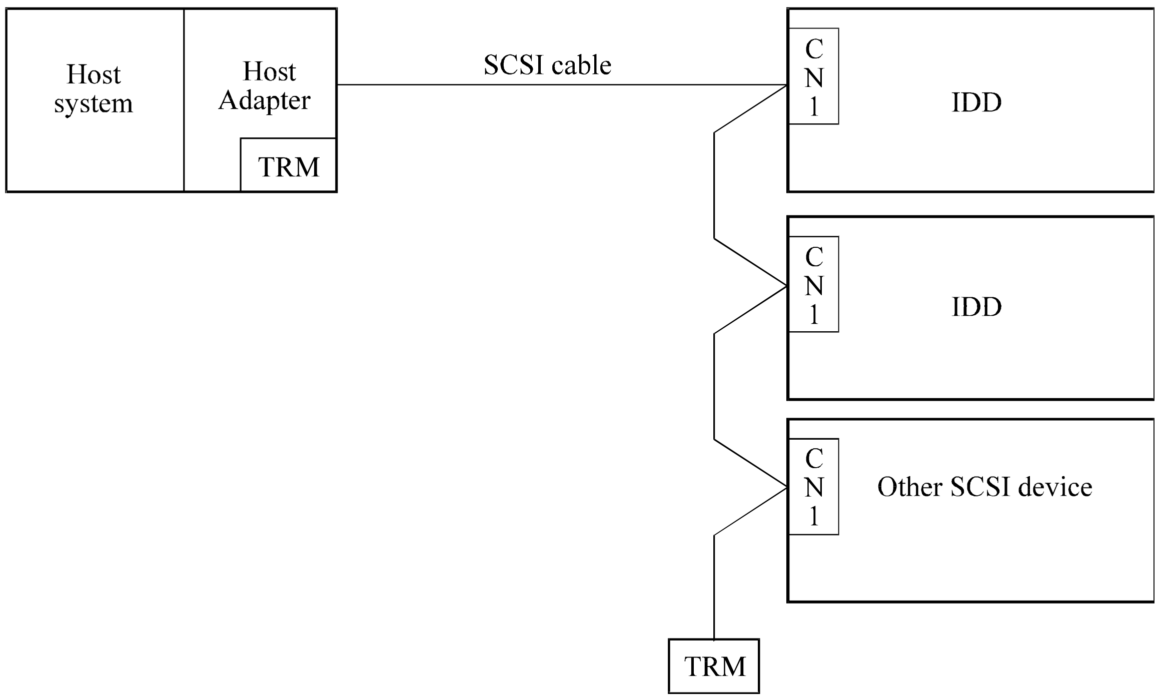


Figure 5.1 SCSI bus connections (1 of 2)

(3) Connecting more than one IDD (multi-host)

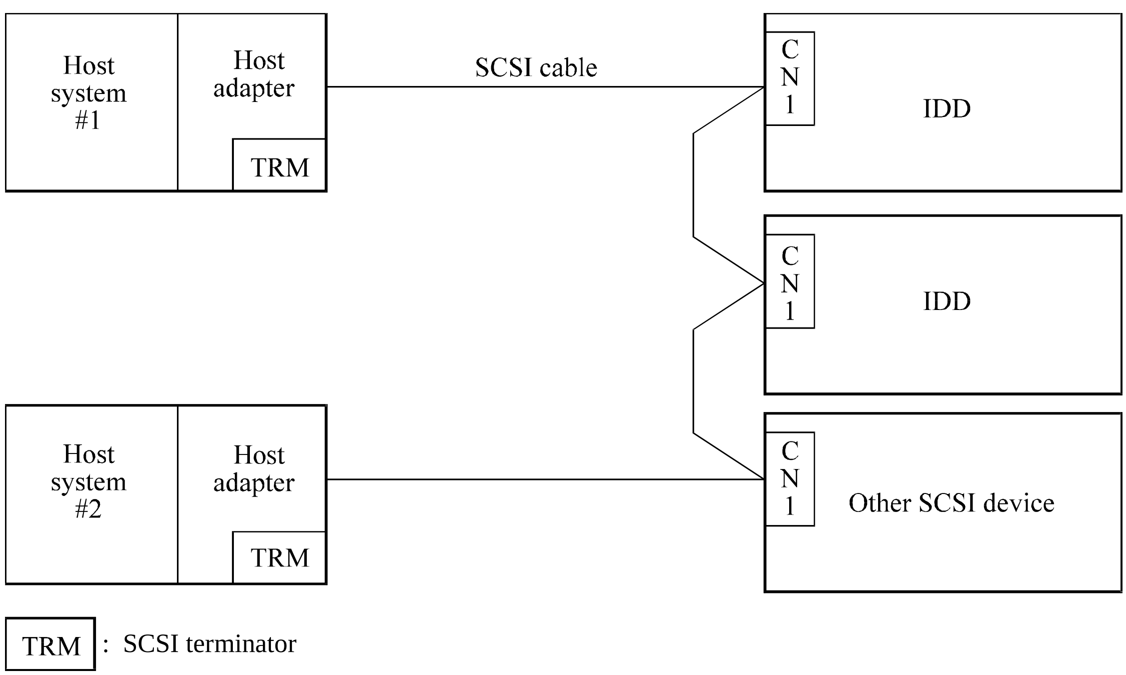


Figure 5.1 SCSI bus connections (2 of 2)

5.3 Setting Terminals

A user sets up the following terminals and SCSI terminating resistor before installing the IDD in the system as required.

- Setting terminal: CN1 (NC model), CN2 (NP model)

Figure 5.2 shows the location of setting terminal (NP model only. For NC model, see Figure 4.13 because the setting terminal is included in SCSI connector CN1.). Figure 5.3 shows the allocation and default settings (NP model only. For allocation of NC model, see Table B.).

⚠CAUTION

Data loss

1. *The user must not change the setting of terminals not described in this section. Do not change setting status set at factory shipment.*

2. *Do not change the setting of terminals except following setting pins during the power is turned on.*

    - *Write protect: CN2 9-10 (NP model only)*

3. *To short the setting terminal, use the short plug attached when the device is shipped from the factory.*

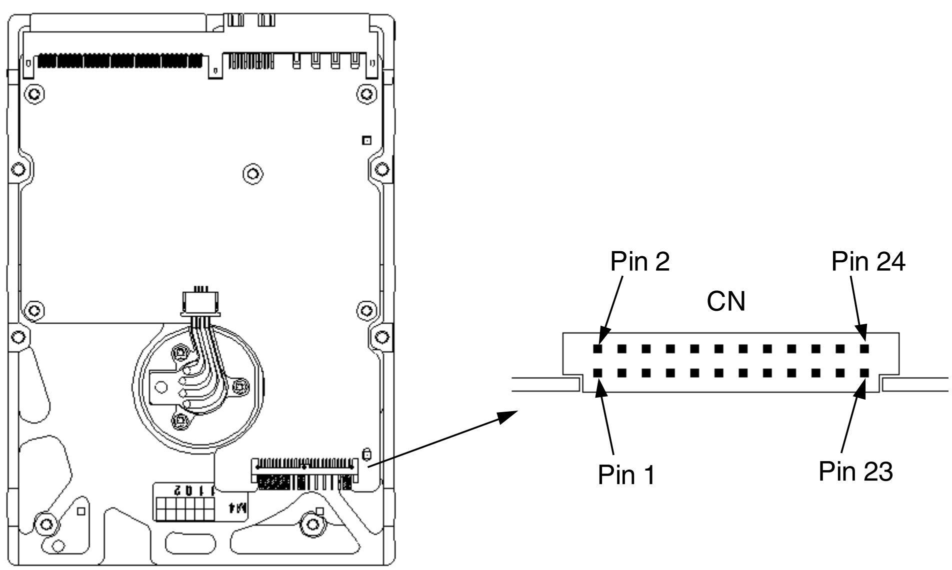


Figure 5.2 Setting terminals location (on NP models only)

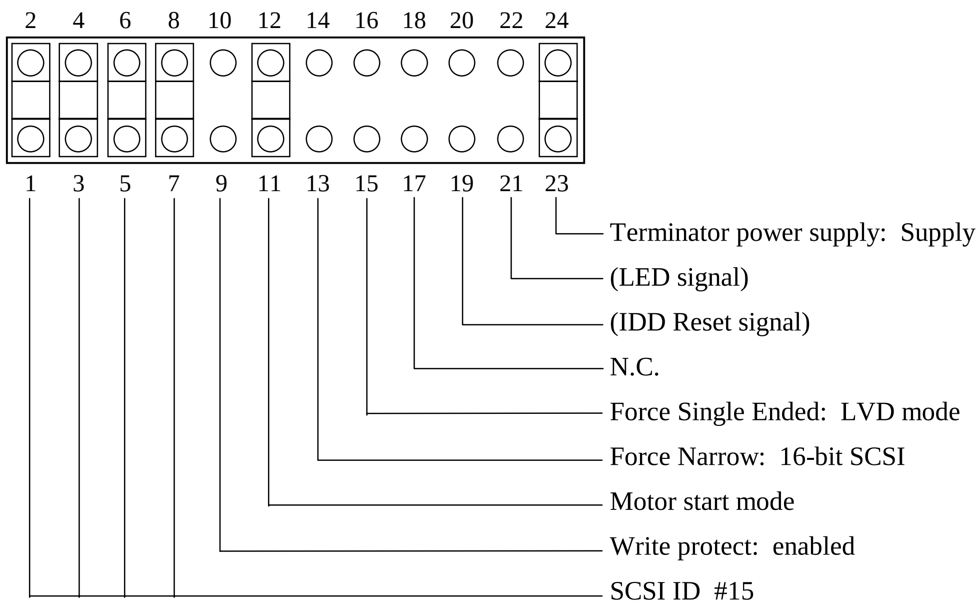


Figure 5.3 CN2 setting terminal (on NP models only)

5.3.1 SCSI ID setting

Table 5.1 shows the SCSI ID setting. For the terminal location and allocation of NC model, see Figure 4.13 and Table B.1. For NP model, see Figure 5.2 and 5.3.

IMPORTANT

When the SCSI ID is set using the external operator panel connector CN1 of NP model, all pins listed in Table 5.1 should be open. If any of pins are shorted, unexpected SCSI ID is set.

Table 5.1 SCSI ID setting

SCSI ID	NC model (CN1)				NP model (CN2)			
	39	79	40	80	1-2	3-4	5-6	7-8
0	Open	Open	Open	Open	Open	Open	Open	Open
1	Short	Open	Open	Open	Short	Open	Open	Open
2	Open	Short	Open	Open	Open	Short	Open	Open
3	Short	Short	Open	Open	Short	Short	Open	Open
4	Open	Open	Short	Open	Open	Open	Short	Open
5	Short	Open	Short	Open	Short	Open	Short	Open
6	Open	Short	Short	Open	Open	Short	Short	Open
7	Short	Short	Short	Open	Short	Short	Short	Open
8	Open	Open	Open	Short	Open	Open	Open	Short
9	Short	Open	Open	Short	Short	Open	Open	Short
10	Open	Short	Open	Short	Open	Short	Open	Short
11	Short	Short	Open	Short	Short	Short	Open	Short
12	Open	Open	Short	Short	Open	Open	Short	Short
13	Short	Open	Short	Short	Short	Open	Short	Short
14	Open	Short	Short	Short	Open	Short	Short	Short
15 (*1)	Short	Short	Short	Short	Short	Short	Short	Short

*1 Set at factory shipment.

IMPORTANT

1. *To set the setting terminals on NC models to short, apply voltage ranging between -0.3 V and 0.8 V to the setting terminals externally. To set the setting terminals on NC models to open, apply voltage ranging between 2.0 V and 5.5 V to the setting terminals from an external source.*

2. *Set the SCSI ID so that there are no duplicates between SCSI devices on the same SCSI bus.*

3. *The priority of SCSI bus use in ARBITRATION phase is determined by SCSI ID as follows:*
   7 > 6 > 5 > 4 > 3 > 2 > 1 > 0 > 15 > 14 > 13 > 12 > 11 > 10 > 9 > 8

5.3.2 Each mode setting

(1) Setting terminator power supply

Refer to Table 5.2 for controlling the supply of power from the drive to the SCSI terminator power source (TERMPOW).

For information on NP model, refer to Figures 5.2 and 5.3.

Table 5.2 Setting SCSI terminator power supply (NP model)

Supply on/off of SCSI terminator power from IDD	CN2 23-24
Supply off	Open
Supply on	Short (*1)

*1. Set at factory shipment.

For NC model, the function of the terminator power supply setting is not supported.

(2) Motor start mode

Set how to control the starting of the IDD spindle motor according to Table 5.3. This setting only determines the operation mode when the power supply is turned on or the microcode is downloaded. In both modes, stopping or restarting the spindle motor can be controlled by specifying the START/STOP UNIT command.

Table 5.3 Motor start mode setting

Start timing of the spindle motor	NC model (*3)		NP model
	CN1 38	CN1 78	CN2 11-12
Starting of the motor is controlled with the START/STOP UNIT command.	Short	Open or Short	Open
The motor is started immediately after the power supply is turned on or after the microcode is downloaded.	Open	Open	Short (*1)
The motor is started after the elapse of a delay time that is based on the SCSI ID. The delay time is provided immediately after the power supply is turned on or after the microprogram is downloaded.	Open	Short	(*2)

*1. Set at factory shipment.

*2. For NP model, delay starting of spindle motor is supported by the CHANGE DEFINITION command only.

*3. To set the setting terminals on NC models to short, apply voltage ranging between-0.3 V and 0.8 V to the setting terminals externally. To set the setting terminals on NC models to open, apply voltage ranging between 2.0 V and 5.5 V to the setting terminals from an external source.

Refer to Chapter 3 of the SCSI Logical Interface Specifications for details of the START/STOP UNIT command.

(3) Write protect

When the write protect function is enabled on NP model, writing to the disk medium is disabled.

Table 5.4 Write protect setting (NP model)

Write protect	CN2 9-10
Write operation is enabled.	Open (*1)
Write operation is disable.	Short

*1. Set at factory shipment.

For NC model, the function of the write protect setting is not supported.

(4) Setting of the SCSI interface operation mode

By establishing a short-circuit between CN2-15 amd CN2-16 on NP model, the SCSI interface operation mode is forcibly set to the single-ended mode. When this setup terminal is open, the IDD automatically identifies the DIFFSNS signal level on the SCSI bus and the IDD SCSI interface operation mode is set to the operation mode.

Table 5.5 Setting of the SCSI interface operation mode (NP model)

Operation mode	CN2 15-16
Follows the DIFFSNS signal level on the SCSI bus	Open (*1)
Single-Ended mode	Short

*1. Set at factory shipment.

For NC model, the function of the SCSI interface operation mode is not supported, so the SCSI interface operation mode follows the level of the DIFFSNS signal on the SCSI bus.

(5) Setting the bus width of the SCSI interface

By establishing a short-circuit between CN2-13 and CN2-14 on NP model, the bus width for the SCSI interface is forcibly set to the 8-bit bus mode. This setup terminal must be set in order to guarantee the physical level of the SCSI interface’s upper bus (DB8-15, P1) inside the IDD only when the top-level bus (DB8-15, P1) for the IDD SCSI interface is not connected to the external part of the IDD.

Table 5.6 Setting the bus width of the SCSI interface (NP model)

Bus width	CN2 13-14
16-bit bus	Open (*1)
8-bit bus	Short

*1. Set at factory shipment.

For NC model, the function of the bus width setting for the SCSI interface is not supported.

5.3.3 Mode settings

In addition to the previously described settings using setting terminals, the IDD is provided with several mode settings. The mode settings are enabled by specifying the CHANGE DEFINITION command. Table 5.7 lists the mode settings and their settings at factory shipment.

Refer to Section 3.1.4 of the SCSI Logical Interface Specifications for details of the command.

Table 5.7 Default mode settings (by CHANGE DEFINITION command)

Mode setting	Contents
SCSI level	SCSI-3
SYNCHRONOUS DATA TRANSFER REQUEST message sending	Not sent from IDD
UNIT ATTENTION report mode	Reported
Reselection retry count	Not restricted
WIDE DATA TRANSFER REQUEST message sending	Not sent from IDD
Reselection time-out delay	250 ms
Spindle motor start delay time	0 sec (NP) 12 sec × SCSI ID (NC)

5.4 Mounting Drives

5.4.1 Check before mounting

Reconfirm if the setting terminals are set correctly according to Table 5.8 before mounting the NP model drives in the system cabinet. For setting terminals location, see Section 5.3.

The NC model drives do not require the following check.

Table 5.8 Setting check list (NP model only)

Setting terminal	No.	Setting contents (Check item)	Setting position	Check	Remarks
CN2	1	SCSI ID	CN2 1 - 2 3 - 4 5 - 6 7 - 8	¤ (SCSI ID = __)	Upper bus (DB 8 to 15 PI) not connected
	2	Write protect	CN2 9 - 10	¤ Short ¤ Open	
	3	Motor start mode	CN2 11 - 12	¤ Short ¤ Open	
	4	Force Narrow	CN2 13 - 14	¤ Short ¤ Open	
	5	Force single ended	CN2 15 - 16	¤ Short ¤ Open	
	6	Terminator power supply	CN2 23 - 24	¤ Short ¤ Open	

5.4.2 Mounting procedures

Since mounting the drive depends on the system cabinet structure, determine the work procedures considering the requirements specific to each system. The general mounting method and items to be checked are shown below.

See Subsection 4.1 for the details of requirements for installing the IDD.

1) With a system to which an external operator panel is mounted, if it is difficult to access the connector after the drive is mounted on the system cabinet, connect the external operator panel cable before mounting the drive.

2) Fix the drive in the system cabinet with four mounting screws as follows:

   - The drive has 10 mounting holes (both sides: 3×2, bottom: 4). Fix the drive by using four mounting holes of both sides or the bottom. (See Figure 4.5)
   - Use mounting screws whose lengths inside the drive mounting frame are 5.0 mm or less when the screws are tightened (see Figure 4.4).
   - When mounting the drive, be careful not to damage parts on the PCAs.

3) Check to ensure that the DE is not touching the frame on the system side after tightening the screws. At least 2.5mm of clearance is required between the DE and the frame. (Indicated in Figure 4.4)

4) When an electric driver is in use, less than device specifications must be used.

5.5 Connecting Cables

Connect the IDD and system with the following cables. See Section 4.3 for further details of the requirements for IDD connector positions and connecting cables.

- Power cable
- SCSI cable
- External operator panel cable (if required for NP model)

The general procedures and notes on connecting cables are described below. Especially, pay attention to the inserting orientation of each cable connector.

⚠CAUTION

Damage

1. *Make sure that system power is off before connecting or disconnecting cables.*

2. *Do not connect or disconnect cables when power is on. (except NC model)*

a) Connect power cable.

b) Connect the external operator panel (if required for NP model).

c) Connect the SCSI cable.

d) Fix the cables so that they do not touch the DE and PCAs, or so that the smooth flow of the cooling air in the system cabinet is assured.

⚠CAUTION

Damage

1. *Be careful of the insertion orientations of the SCSI connectors. With the system in which terminating resistor power is supplied via the SCSI cable, if the power is turned on, the overcurrent protection fuse of the terminating resistor power supplier may be blown or the cable may be burnt if overcurrent protection is not provided.*

   When the recommended parts listed in Table 4.2 are used, inserting the cables in the wrong orientation can be prevented.

2. *To connect SCSI devices, be careful of the connection position of the cable. Check that the SCSI device with the terminating resistor is the last device connected to the cable.*

5.6 Confirming Operations after Installation and Preparation for Use

5.6.1 Confirming initial operations

This section describes the operation check procedures after power is turned on. Since the initial operation of the IDD depends on the setting of the motor start mode, check the initial operation by either of the following procedures.

(1) Initial operation in the case of setting so that motor starts at powering-on

a) When power is turned on, the LED blinks an instant and the IDD executes initial self-diagnosis.

b) If an error is detected in the initial self-diagnosis, the LED blinks periodically.

Remark:

The spindle motor may or may not start rotating in this stage.

c) When the IDD status is idle, the LED remains off (when the initiator accesses the IDD via the SCSI bus, the LED lights).

(2) Initial operation in the case of setting so that motor starts with START/STOP command

a) When power is turned on, the LED blinks an instant and the IDD executes initial self-diagnosis.

b) If an error is detected in the initial self-diagnosis, the LED blinks.

c) The spindle motor does not start rotating until the START/STOP UNIT command for the start is issued. The INIT needs to issue the START/STOP UNIT command to start the spindle motor by the procedure in Subsection 5.6.2.

d) The disk drive enters the READY status in 60 seconds after the START/STOP UNIT command is issued. At this time, the IDD reads "system information" from the system space on the disk.

e) The LED blinks during command execution.

(3) Check items at illegal operation

a) Check that cables are mounted correctly.

b) Check that power and voltages are supplied correctly (measure them with the IDD power connection position).

c) Check the setting of each setting terminal. Note that the initial operation depends on the setting of the motor start mode and LED display requirements.

d) If an error is detected in initial self-diagnosis the LED blinks. In this case, it is recommended to issue the REQUEST SENSE command from the initiator (host system) to obtain information (sense data) for error analysis.

IMPORTANT

The LED lights during the IDD is executing a command. However, in same commands, the lighting time is only an instant. Therefore, it seems that the LED blinks or the LED remains off.

5.6.2 Checking SCSI connection

When the initial operation is checked normally after power is turned on, check that the IDD is connected to the SCSI bus from the host system. Although checking the connection depends on the structure of the host system, this section describes the general procedures.

(1) Checking procedure

Issuing the commands and determining the end status depends on the start mode of the spindle motor and UNIT ATTENTION report mode (specified with setting terminal). Figure 5.4 shows the recommended checking procedure for the mode that the motor starts when power is turned on. Figure 5.5 shows for the mode that the motor starts by the START/STOP command. In these recommended checking procedures, following items are checked.

Note:

Following steps a) to d) correspond to a) to d) in Figures 5.4 and 5.5.

a) Issue the TEST UNIT READY command and check that the IDD is connected correctly to the SCSI bus and the initial operation after power is turned on ended normally. The command issue period of the TEST UNIT READY command shall be more than 20 ms.

b) To control starting of the spindle motor from the host system, issue the START/STOP UNIT command to start the spindle motor.

c) Check the SCSI bus operations with the WRITE BUFFER and READ BUFFER commands. Use data whose data bus bits change to 0 or 1 at least once. (Example: Data with an increment pattern of X'00' to X'FF')

d) Start the IDD self-diagnostic test with the SEND DIAGNOSTIC command and check the basic operations of the controller and disk drive.

Motor starts when power is turned on

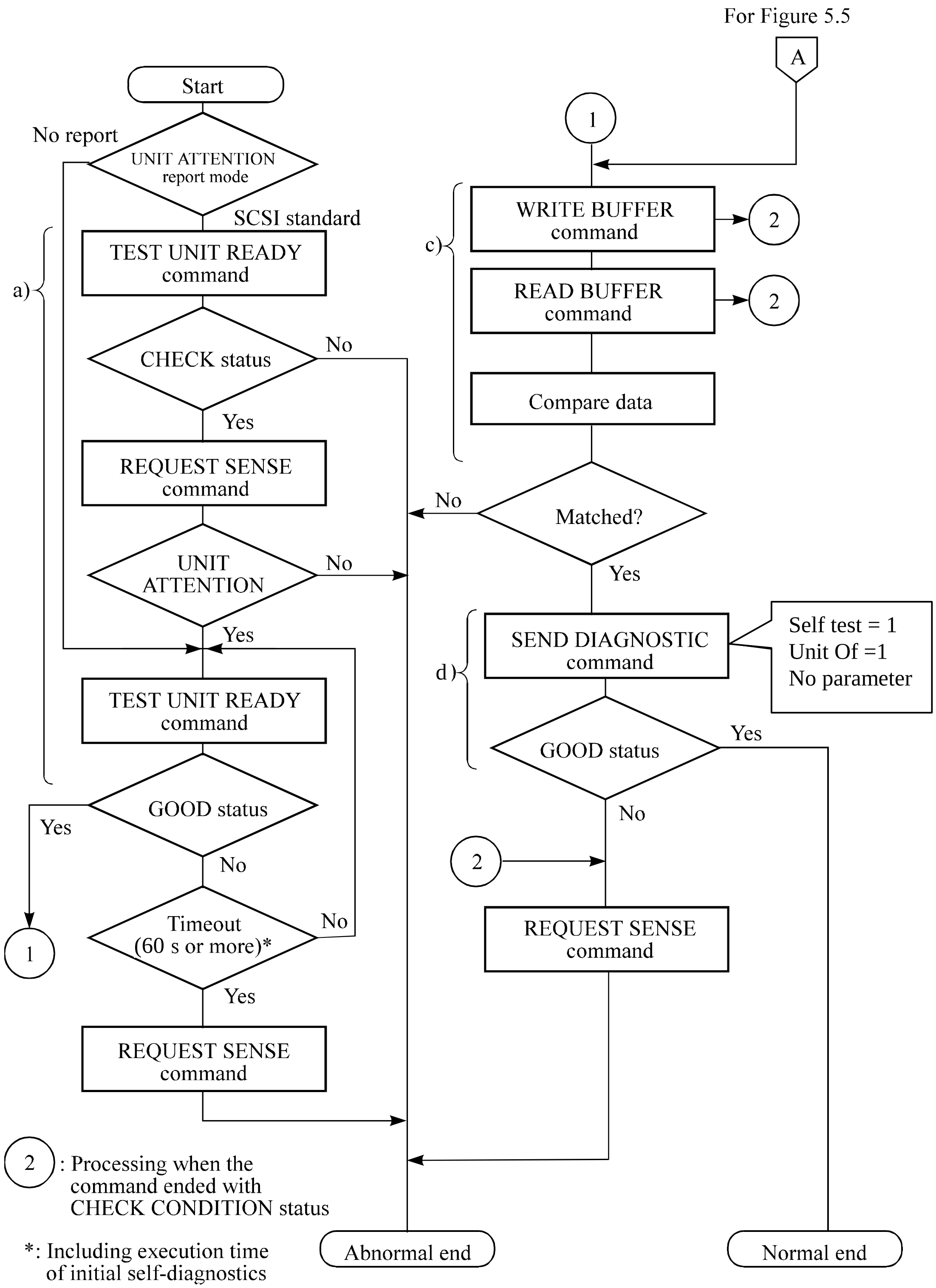


Figure 5.4 Checking the SCSI connection (A)

Motor starts by START/STOP command

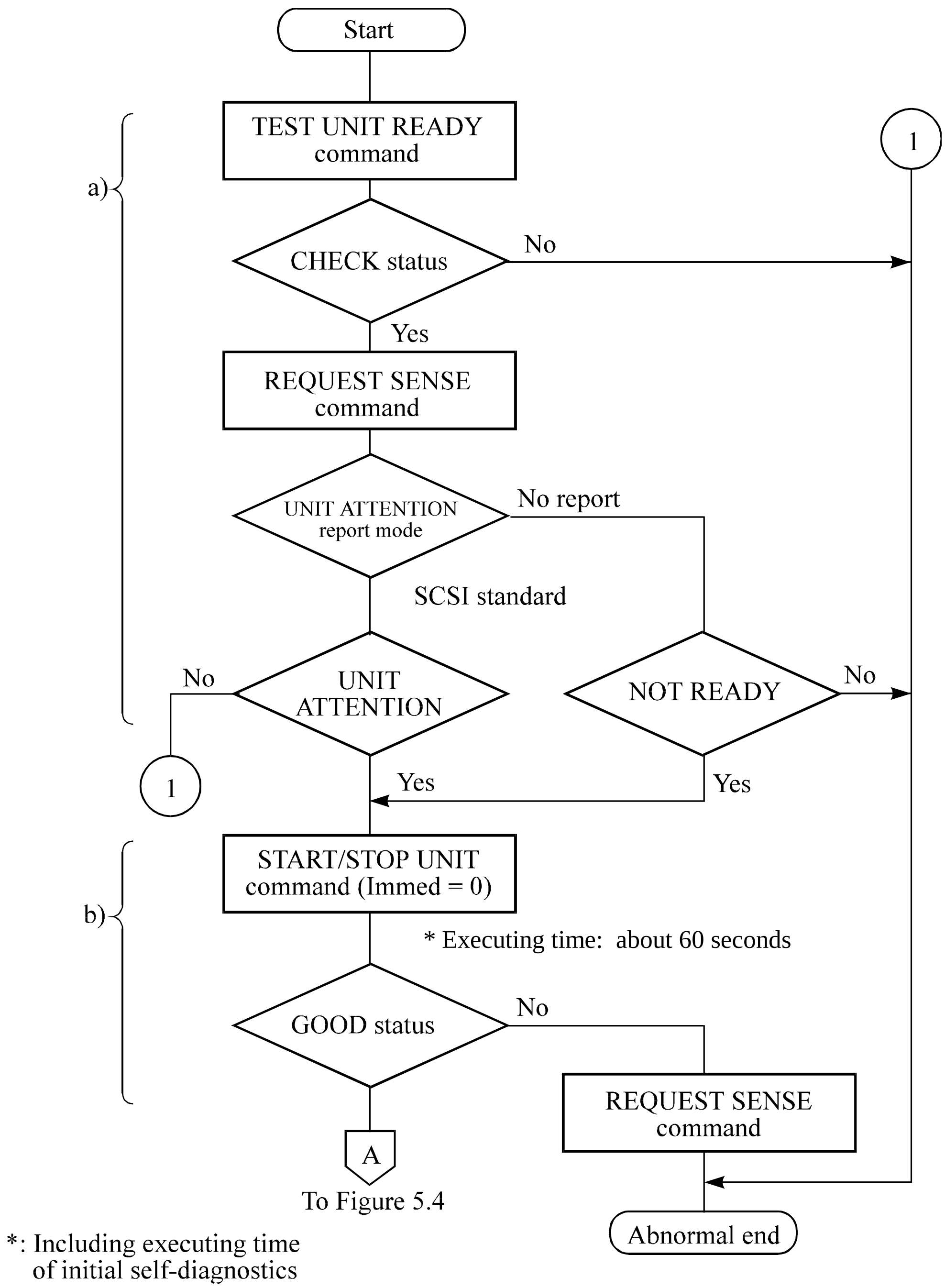


Figure 5.5 Checking the SCSI connection (B)

(2) Checking at abnormal end

a) When sense data can be obtained with the REQUEST SENSE command, analyze the sense data and retry recovery for a recoverable error. Refer to Chapter 5 of SCSI Logical Interface Specifications for further details.

b) Check the following items for the SCSI cable connection:

- All connectors including other SCSI devices are connected correctly.
- The terminating resistor is mounted on both ends of the cable.
- Power is connected to the terminating resistor.

c) Check the setting of the terminals. Note that the checking procedure of SCSI connection differs depending on the setting of the motor start mode and UNIT ATTENTION report mode.

5.6.3 Formatting

Since the disk drive is formatted with a specific (default) data format for each model (part number) when shipped from the factory, the disk need not be formatted (initialized) when it is installed in the system.

However, when the system needs data attributes different from the default format, all recording surface of the disk must be formatted (initialized) according to the procedures below.

The user can change the following data attributes at initialization:

- Logical data block length
- Number of logical data blocks in the user space
- Alternate spare area size

This section outlines the formatting at installation. Refer to Chapters 3 and 6 of SCSI Logical Interface Specifications for further details.

(1) MODE SELECT/MODE SELECT EXTENDED command

Specify the format attributes on the disk with the MODE SELECT or MODE SELECT EXTENDED command. The parameters are as follows.

a. Block descriptor

Specify the size (byte length) of the logical data block in the "data block length" field. To explicitly specify the number of logical data blocks, specify the number in the "number of data blocks" field. Otherwise, specify 0 in "number of data blocks" field. In this case, the number of logical data blocks after initialization is determined by the value specified in the format parameter (page code = 3) and drive parameter (page code = 4).

b. Format parameter (page code = 3)

Specify the number of spare sectors for each cell in the "alternate sectors/zone" field. It is recommended not to specify values smaller than the IDD default value in this field.

(2) FORMAT UNIT command

Initialize all recording surface of the disk with the FORMAT UNIT command. The FORMAT UNIT command initializes all surface of the disk using the P lists, verifies data blocks after initialization, and allocates an alternate block for a defect block detected with verification. With initialization, the value "00" is written into all bytes of all logical data blocks. Only the position information of defect blocks detected with verification is registered in the G list. The specifications are as follows:

a. Specifying CDB

Specify 0 for the "FmtData" bit and the "CmpLst" bit on CDB, 000 for the "Defect List Format" field, and data pattern written into the data block at initialization for the "initializing data pattern" field.

b. Format parameter

When the values in step a. are specified with CDB, the format parameter is not needed.

5.6.4 Setting parameters

The user can specify the optimal operation mode for the user system environments by setting the following parameters with the MODE SELECT or MODE SELECT EXTENDED command:

- Error recovery parameter
- Disconnection/reconnection parameter
- Caching parameter
- Control mode parameter

With the MODE SELECT or MODE SELECT EXTENDED command, specify 1 for the "SP" bit on CDB to save the specified parameter value on the disk. This enables the IDD to operate by using the parameter value set by the user when power is turned on again. When the system has more than one INIT, different parameter value can be set for each INIT.

When the parameters are not set or saved with the MODE SELECT or MODE SELECT EXTENDED command, the IDD sets the default values for parameters and operates when power is turned on or after reset. Although the IDD operations are assured with the default values, the operations are not always optimal for the system. To obtain the best performance, set the parameters in consideration of the system requirements specific to the user.

This section outlines the parameter setting procedures. Refer to Chapter 3 of SCSI Logical Interface Specifications for further details of the MODE SELECT and MODE SELECT EXTENDED commands and specifying the parameters.

IMPORTANT

1. *At factory shipment of the IDD, the saving operation for the MODE SELECT parameter is not executed. So, if the user does not set parameters, the IDD operates according to the default value of each parameter*

2. *The MODE SELECT parameter is not saved for each SCSI ID of but as the common parameter for all IDs. In the multi-INIT System, parameter setting cannot be changed for each INIT.*

3. *Once parameters are saved, the saved value is effective as long as next saving operation is executed from the INIT. For example, even if the initialization of the disk is performed by the FORMAT UNIT command, the saved value of parameters described in this section is not affected.*

4. *When the IDD, to which the saving operation has been executed on a system, is connected to another system, the user must pay attention to that the IDD operates according to the saved parameter value if the saving operation is not executed at installation.*

5. *The saved value of the MODE SELECT parameter is assumed as the initial value of each parameter after the power-on, the RESET condition, or the BUS DEVICE RESET message. The INIT can change the parameter value temporary (actively) at any timing by issuing the MODE SELECT or MODE SELECT EXTENDED command with specifying "0" to the SP bit in the CDB.*

(1) Error recovery parameter

The following parameters are used to control operations such as IDD internal error recovery:

a. Read/write error recovery parameters (page code = 1)

Parameter		Default value
• AWRE:	Automatic alternate block allocation at Write operation	1 (enabled)
• ARRE:	Automatic alternate block allocation at read operation	1 (enabled)
• TB:	Uncorrectable data transfer to the INIT	1 (enabled)
• EER:	Immediate correction of correctable error	1 (enabled)
• PER:	Report of recovered error	0 (disabled)
• DCR:	Suppression of ECC error correction	0 (Correction is enabled.)
• Retry count at read operation		63
• Retry count at write operation		63
• Recovery time limit		30 sec

b. Verify error recovery parameters (page code = 7)

Parameter		Default value
• ERR:	Immediate correction of recoverable error	1 (enabled)
• PER:	Report of recovered error	0 (disabled)
• DTE:	Stop of command processing at successful error recovery	0 (Processing is continued.)
• DCR:	Suppression of ECC error correction	0 (Correction is enabled.)
• Retry count at verification		63

c. Additional error recovery parameters (page code = 21)

Parameter	Default value
• Retry count at seek error	15

Notes:

1. The user can arbitrarily specify the following parameters according to the system requirements:

   - ARRE
   - AWRE
   - TB
   - PER

2. The user also can arbitrarily specify parameters other than the above. However, it is recommended to use the default setting in normal operations.

(2) Disconnection/reconnection parameters (page code = 2)

The following parameters are used to optimize the start timing of reconnection processing to transfer data on the SCSI bus at a read (READ or READ EXTENDED command) or write operation (WRITE, WRITE EXTENDED, or WRITE AND VERIFY command) of the disk. Refer to Chapter 2 of SCSI Logical Interface Specifications for further details.

Parameter	Default value
• Buffer full ratio	00 (HEX)
• Buffer empty ratio	00 (HEX)

Notes:

1. In a system without the disconnection function, these parameters need not be specified.

2. Determine the parameter values in consideration of the following performance factors of the system:

   - Time required for reconnection processing
   - Average data transfer rate of the SCSI bus
   - Average amount of processing data specified with a command

   Refer to Chapter 2 of SCSI Logical Interface Specifications for how to obtain the rough calculation values for the parameter values to be set. It is recommended to evaluate the validity of the specified values by measuring performance in an operation status under the average system load requirements.

(3) Caching parameters

The following parameters are used to optimize IDD Read-Ahead caching operations under the system environments. Refer to Chapter 2 of SCSI Logical Interface Specifications for further details.

Parameter		Default value
• IC:	Initiator control	0 (Drive-specific control (page cache))
• RCD:	Disabling Read-Ahead caching operations	0 (enabled)
• WCE:	Write Cache Enable	1 (enabled)
• MS:	Specifying the multipliers of "minimum prefetch" and "maximum prefetch" parameters	0 (Specifying absolute value)
• DISC:	Prefetch operation after track switching during prefetching	1 (enable)
• Number of blocks for which prefetch is suppressed		X'FFFF'
• Minimum prefetch		X'0000'
• Maximum prefetch		X' XXXX' (1 cache segment)
• Number of blocks with maximum prefetch restrictions		X'FFFF'
• Number of segments		X'08'

Notes:

1. When Read-Ahead caching operations are disabled by the caching parameter, these parameter settings have no meaning except write cache feature.

2. Determine the parameters in consideration of how the system accesses the disk. When the access form is not determined uniquely because of the processing method, the parameters can be re-set actively.

3. For sequential access, the effective access rate can be increased by enabling Read-Ahead caching operations and Write Cache feature.

(4) Control mode parameters

The following parameters are used to control the tagged queuing and error logging.

a. Control mode parameters

Parameter		Default value
• Queue algorithm modifier		0 (Execution sequence of read/write commands is optimized.)
• QErr:	Resume or abort remaining suspended commands after sense pending state	0 (command is resumed)
• DQue:	Disabling tagged command queuing	0 (enabled)

5.7 Dismounting Drives

Since dismounting the drive to check the setting terminals, change the setting, or change the drive depends on the structure of the system cabinet, the work procedures must be determined in consideration of the requirements specific to the system. This section describes the general procedures and notes on dismounting the drive.

It is recommended before dismounting the drive to make sure the spindle motor completely stops after power was turned off.

a) Remove the power cable.

b) Remove the SCSI cable.
NC Model uses a single cable for power supply and the SCSI interface.

c) When the external operator panel is mounted, remove the cable. If it is difficult to access the connector position, the cable may be removed after step e).

d) Remove the DC ground cable.

e) Remove the four mounting screws securing the drive, then remove the drive from the system cabinet.

f) To store or transport the drive, keep it in an antistatic bag and provide packing (see Section 5.1).

5.8 Spare Disk Drive

See 2.1.1, “Model name and order number,” to order a disk drive for replacement or as a spare.

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CHAPTER 6 DIAGNOSTICS AND MAINTENANCE

This chapter describes diagnostics and maintenance information.

6.1 Diagnostics

6.1.1 Self-diagnostics

The IDD has the following self-diagnostic function. This function checks the basic operations of the IDD.

- Initial self-diagnostics
- Online self-diagnostics (SEND DIAGNOSTIC command)

Table 6.1 lists the contents of the tests performed with the self-diagnostics. For a general check of the IDD including the operations of the host system and interface, use a test program that runs on the host system (see Subsection 6.1.2).

Table 6.1 Self-diagnostic functions

Test contents	Initial self-diagnostics	SEND DIAGNOSTIC command	
		Self Test=1 Unit Offline=0	Self Test=1 Unit Offline=1
Hardware function test	○	○	○ ↓
Seek test			○ ↓
Write/read test (Cylinder for internal test)			○

Note:

○ indicates the tests to be executed and arrows show the sequence of execution.

Brief test contents of self-diagnostics are as follows.

a. Hardware function test

This test checks the basic operation of the controller section, and contains following test.

- RAM (microcode is stored)
- Peripheral circuits of microprocessor (MPU)
- Memory (RAM)
- Data buffer

b. Seek test

This test checks the positioning operation of the disk drive using several seek modes (2 points seek, 1 position sequential seek, etc.). The positioning operation is regarded as success when the seek operation to the target cylinder is completed.

c. Write/read test

This test checks the write/read function by using the Internal test space of the disk drive.

(1) Initial self-diagnostics

When power is turned on, the IDD starts initial self-diagnostics. The initial self-diagnostics checks the basic operations of the hardware functions.

If an error is detected in the initial self-diagnostics, the LED on the drive front panel blinks. In this status, the IDD posts the CHECK CONDITION status to all I/O operation requests other than the REQUEST SENSE command. When the CHECK CONDITION status is posted, the INIT should issue the REQUEST SENSE command. The sense data obtained with the REQUEST SENSE command details the error information detected with the initial self-diagnostics.

Even if CHECK CONDITION status and sense data are posted, the LED continues blinking. Only when the power is turned off or re-turned on, this status can be cleared. When this status is cleared, the IDD executes the initial self-diagnosis again.

The IDD does not reply to the SCSI bus for up to 2 seconds after the initial self-diagnostics is started. After that, the IDD can accept the I/O operation request correctly, but the received command, except the executable commands under the not ready state (such as INQUIRY, START/STOP UNIT), is terminated with the CHECK CONDITION status (NOT READY [=2]/logical unit is in process of becoming ready [=04-01] or logical unit not ready, initializing command required [=04-02]) during the interval from the spindle motor becomes stable to the IDD becomes ready. The executable command under the not ready state is executed in parallel with the initial self-diagnostics, or is queued by the command queuing feature and is executed after completion of the initial self-diagnostics. When the command that comes under the exception condition of the command queuing is issued at that time, the IDD posts the BUSY status for the command. When the error is detected during the initial self-diagnostics, the CHECK CONDITION status is posted for all commands that were stacked during the initial self-diagnostics. For the command execution condition, refer to Section 1.4 and Subsection 1.7.4 in SCSI Logical Interface Specifications.

(2) Online self-diagnostics (SEND DIAGNOSTIC command)

The INIT can make the IDD execute self-diagnostics by issuing the SEND DIAGNOSTIC command.

The INIT specifies the execution of self-diagnostics by setting 1 for the SelfTest bit on the CDB in the SEND DIAGNOSTIC command and specifies the test contents with the UnitOfl bit.

When the UnitOfl bit on the CDB is set to 0, the IDD executes the hardware function test only once. When UnitOfl bit is set to 1, the IDD executes the hardware function test, seek (positioning) test, and data write/read test for the Internal test space only once.

a. Error recovery during self-diagnostics

During the self-diagnostics specified by the SEND DIAGNOSTIC command, when the recoverable error is detected during the seek or the write/read test, the IDD performs the error recovery according to the MODE SELECT parameter value (read/write error recovery parameter, additional error recovery parameter) which the INIT specifies at the time of issuing the SEND DIAGNOSTIC command.

PER	Operation of self-diagnostics
0	The self-diagnostics continues when the error is recovered. The self-diagnostics terminates normally so far as the unrecoverable error is not detected.
1	The self-diagnostics continues when the error is recovered. If the unrecoverable error is not detected, the consecutive tests are executed till last test but the self-diagnostics terminates with error. The error information indicates that of the last recovered error.

b. Reporting result of self-diagnostics and error indication

When all specified self-diagnostics terminate normally, the IDD posts the GOOD status for the SEND DIAGNOSTIC command.

When an error is detected in the self-diagnostics, the IDD terminates the SEND DIAGNOSTIC command with the CHECK CONDITION status.

The INIT should issue the REQUEST SENSE command when the CHECK CONDITION status is posted. The sense data collected by the REQUEST SENSE command indicates the detail information of the error detected in the self-diagnostics.

The IDD status after the CHECK CONDITION status is posted differs according to the type of the detected error.

a) When an error is detected in the seek or write/read test, the subsequent command can be accepted correctly. When the command other than the REQUEST SENSE and NO OPERATION is issued from the same INIT, the error information (sense data) is cleared.

b) When an error is detected in the hardware function test, the IDD posts the CHECK CONDITION status for all I/O operation request except the REQUEST SENSE command. The error status is not cleared even if the error information (sense data) is read. Only when the power is turned off or re-turned on, the status can be cleared. When this status is cleared, the IDD executes the initial self-diagnostics again (see item (1)).

Refer to Chapter 3 of SCSI Logical Interface Specifications for further details of the command specifications.

⚠CAUTION

Data loss
When the SEND DIAGNOSTIC command terminates with the CHECK CONDITION status, the INIT must collect the error information using the REQUEST SENSE command. The RECEIVE DIAGNOSTIC RESULTS command cannot read out the error information detected in the self-diagnostics.

6.1.2 Test programs

The basic operations of the IDD itself can be checked with the self-diagnostic function. However, to check general operations such as the host system and interface operations in a status similar to the normal operation status, a test program that runs on the host system must be used.

The structure and functions of the test program depend on the user system requirements. Generally, it is recommended to provide a general input/output test program that includes SCSI devices connected to the SCSI bus and input/output devices on other I/O ports.

Including the following test items in the test program is recommended to test the IDD functions generally.

(1) Interface (SCSI bus) test

The operations of the SCSI bus and data buffer on the IDD are checked with the WRITE BUFFER and READ BUFFER commands.

(2) Basic operation test

The basic operations of the IDD are checked by executing self-diagnosis with the SEND DIAGNOSTIC command (see Subsection 6.1.1).

(3) Random/sequential read test

The positioning (seek) operation and read operation are tested in random access and sequential access modes with the READ, READ EXTENDED, or VERIFY command.

(4) Write/read test

By using a data block in the internal test space, the write/read test can be executed with an arbitrary pattern for a disk drive in which user data is stored.

6.2 Maintenance Information

6.2.1 Precautions

Take the following precautions to prevent injury during maintenance and troubleshooting:

⚠CAUTION

1. *To avoid shocks, turn off the power before connecting or disconnecting a cable, connector, or plug.*

2. *To avoid injury, do not touch the mechanical assembly during disk drive operation.*

3. *Do not use solvents to clean the disk drive.*

Take the following precautions to prevent disk drive damage during maintenance and troubleshooting:

⚠CAUTION

1. *Always ground yourself with a wrist strap connected to ground before handling. ESD (Electrostatics Discharge) may cause the damage to the device.*

2. *To prevent electrical damage to the disk drive, turn the power off before connecting or disconnecting a cable, connector, or plug.*

3. *Do not remove a PCA.*

4. *Do not use a conductive cleaner to clean a disk drive assembly.*

5. *Ribbon cables are marked with a colored line. Connect the ribbon cable to a cable connector with the colored wire connected to pin 1.*

6.2.2 Maintenance requirements

(1) Preventive maintenance

Preventive maintenance such as replacing air filters is not required.

⚠CAUTION

Damage
Never open the disk enclosure in the field.
Opening the disk enclosure may cause an irreparable fault.

(2) Service life

See "(3) Service life," in Section 2.1.5.

(3) Parts that can be replaced in the field

The PCA cannot be replaced in the field. The DE cannot be replaced in the field.

(4) Service system and repairs

Fujitsu has the service system and repair facility for the disk drive. Contact Fujitsu representative to submit information for replacing or repairing the disk drive. Generally, the following information must be included:

a) IDD model, part number (P/N), revision number, serial number (S/N), and date of manufacturing

b) Error status

- Date when the error occurred
- System configuration
- Environmental conditions (temperature, humidity, and voltage)

c) Error history

d) Error contents

- Outline of inconvenience
- Issued commands and specified parameters
- Sense data
- Other error analysis information

⚠CAUTION

Data loss
Save data stored on the disk drive before requesting repair. Fujitsu does not assume responsibility if data is destroyed during servicing or repair.

See Section 5.1 for notes on packing and handling when returning the disk drive.

6.2.3 Maintenance levels

If a disk drive is faulty, replace the whole disk drive since repair requires special tools and environment. This section explains the two maintenance levels.

(1) Field maintenance (disk drive replacement)

- This replacement is done at the user's site.
- Replacement uses standard tools.
- Replacement is usually done by the user, retail dealer, distributor, or OEM engineer.

(2) Factory maintenance (parts replacement)

- This replacement can only be done by Fujitsu.
- Replacement includes maintenance training and OEM engineer support. OEM engineers usually support retail dealers and distributors.
- Replacement uses factory tools and test equipment.

6.2.4 Revision numbers

The revision number of the disk drive is represented with a letter and a number indicated on the revision label attached to the DE. Figure 6.1 shows the revision label format.

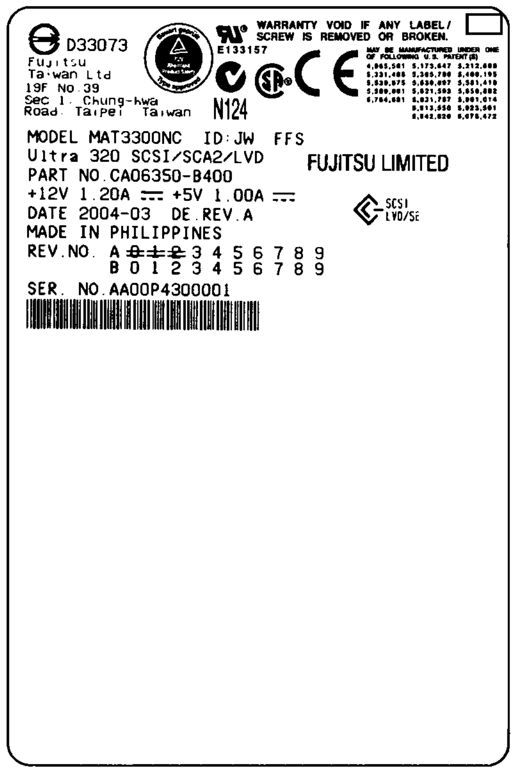


Figure 6.1 Revision label

(1) Indicating revision number at factory shipment

When the disk drive is shipped from the factory, the revision number is indicated by deleting numbers in the corresponding letter line up to the corresponding number with = (see Figure 6.2).

(2) Changing revision number in the field

To change the revision number because parts are replaced or other modification is applied in the field, the new level is indicated by enclosing the corresponding number in the corresponding letter line with ¡ (see Figure 6.2).

IMPORTANT

When the revision number is changed after the drive is shipped from the factory, Fujitsu issues "Engineering Change Request/Notice" in which the new revision number is indicated. When the user changes the revision number, the user should update the revision label as described in item (2) after applying the modification.

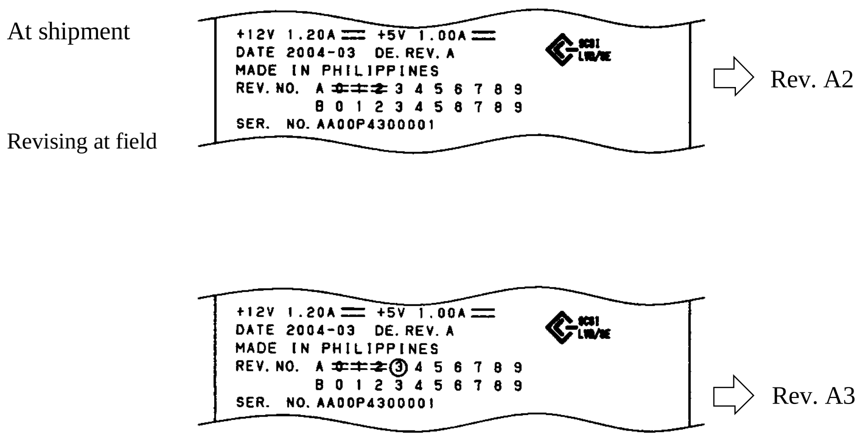


Figure 6.2 Indicating revision numbers

6.2.5 Tools and test equipment

Disk drive troubleshooting and repair in the field require only standard SCSI tools. No special tools or test equipment are required.

This manual does not describe the factory-level tools and test equipment.

6.2.6 Tests

This disk drive can be tested in the following ways:

- Initial seek operation check (See Subsection 6.3.1)
- Operation test (See Subsection 6.3.2)
- Diagnostic test (See Subsection 6.3.3)

Figure 6.3 shows the flow of these tests.

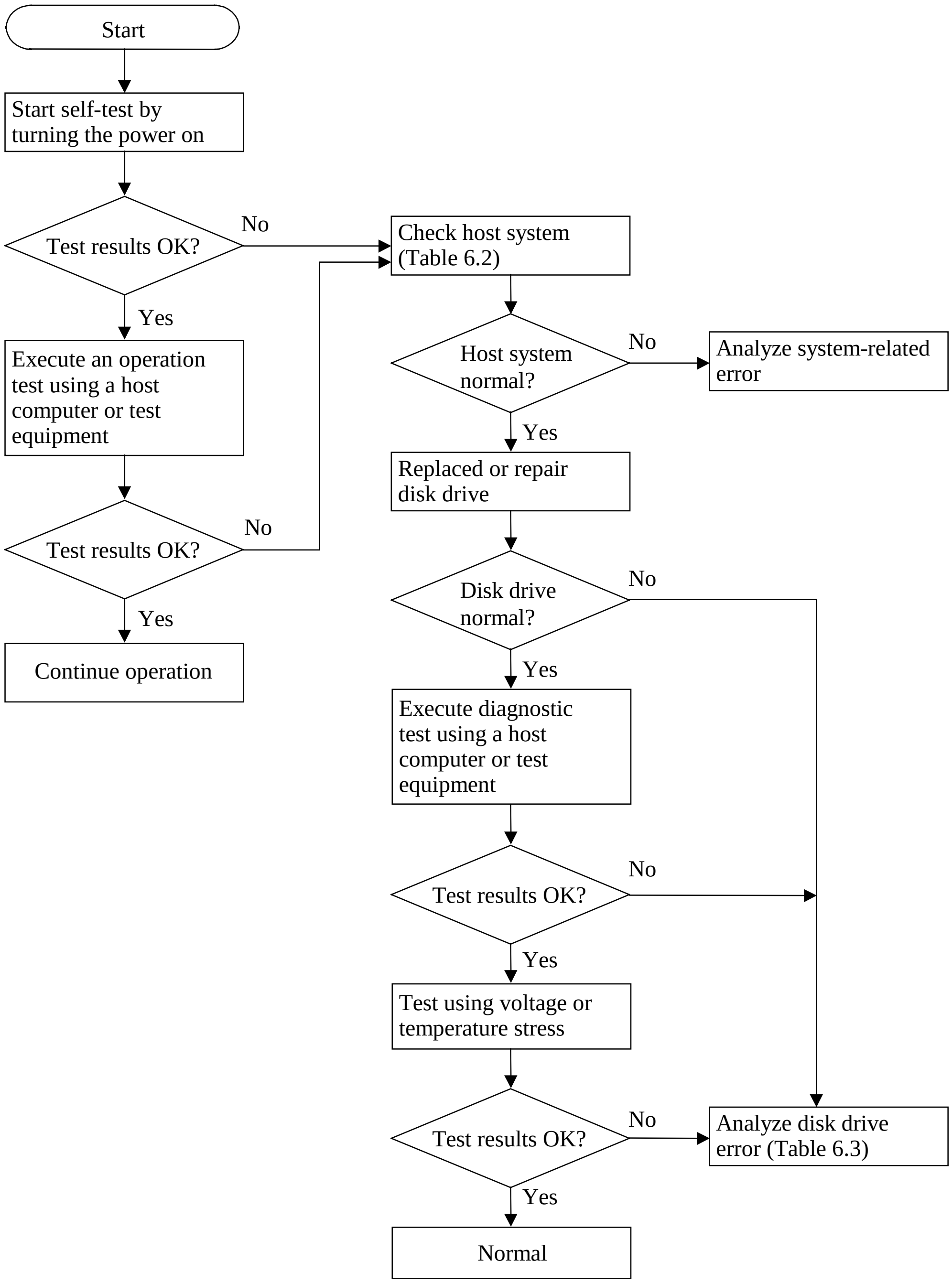


Figure 6.3 Test flowchart

6.3 Operation Check

6.3.1 Initial seek operation check

If an error is detected during initialization by the initial seek operation check routine at power-on, the LED on the front panel blinks. The spindle motor of the disk drive then stops, and the disk drive is unusable.

For an explanation of the operation check before the initial seek, refer to the Section 5.6.

6.3.2 Operation test

While the host computer is processing data, the IDD monitors disk drive operation including data processing, command processing, and seek operations. If the IDD detects an error, the IDD posts the error to the INIT. The INIT then posts the error to the user.

The user may detect an intermittent or nonfatal error such as abnormal noise, abnormal odor, or very slow operation.

An error posted in an operation test must be investigated. Replace the disk drive to see whether the error was caused by the disk drive.

Often, errors posted in an operation test may be caused by the host system. Possible causes include insufficient power capacity, loose cable connection, insufficient timing or insufficient mechanical play, and problems related to other systems.

If an operation error is detected by the error detection circuit of the disk drive, an interrupt occurs. The interrupt is posted to the MCU on the PCA. The MCU stops the currently processed command, and causes the CHECK CONDITION status to post the error to the INIT.

When receiving the CHECK CONDITION status, the INIT issues a REQUEST SENSE command to collect detailed information about the error. The INIT then issues a REZERO UNIT command to return the read/write head to track 00. In normal processing, the IDD itself or INIT determines how to handle the error (processing retry or stop).

To analyze the error posted in the operation test, reconstruct the conditions in which the error occurred. Then, start troubleshooting the whole host system by replacing the disk drive.

6.3.3 Diagnostic test

The diagnostic test is executed to find a faulty subassembly in a faulty disk drive, or to check disk drive performance. This test is usually a combination of specific disk drive functions or group of functions. This test may be executed using a different host computers or test equipment and away from the environment where the error first occurred.

To analyze the error posted in the diagnostic test, reconstruct the conditions in which the error occurred. Then, look for a possibly faulty subassembly or part of the disk drive.

The procedures to be used in this test depend largely on the type of test equipment used, and are not covered by this manual.

6.4 Troubleshooting Procedures

6.4.1 Outline of troubleshooting procedures

This section explains the troubleshooting procedures for disk drive errors.

Depending on the maintenance level, analyze the error to detect a possibly faulty part (disk drive, or disk drive part).

Full-scale troubleshooting is usually required if the error cause is not known. If the error cause is clear (e.g., abnormal noise in disk enclosure or burning of a PCA), troubleshooting is straightforward.

6.4.2 Troubleshooting with disk drive replacement in the field

At this level of maintenance, we recommend replacing the disk drive as a unit. If replacing the disk drive rectifies the fault, return the removed disk drive to the factory, for test and repair. If the newly installed disk drive does not rectify the fault another part of the system is faulty.

Table 6.2 summarizes system-level field troubleshooting. Troubleshooting must be done in the field, to find faulty part (disk drive or system).

Table 6.2 System-level field troubleshooting

Item	Recommended work
DC power cable	Check that the power cable is correctly connected to the disk drive and power supply unit.
DC power level	Check that the DC voltage is within the specified range (±5%).
	Check that the +5 VDC value (pins 3 and 4 of the power connector) is 4.75 to 5.25 VDC.
	Check that the +12 VDC supply (pins 1 and 2 of the power connector of disk drive) is 11.4 to 12.6 VDC.
Electrical noise	Make sure the maximum ripple peak-to-peak value of +5 VDC is within 250 mV and +12 VDC is within 250 mV.
	Make sure the high frequency noise (over 20 MHz) is less than 100 mVp-p.
Interface cable connection	Check that the SCSI interface cable is correctly connected between the disk drive and controller.
Terminating resistors	For a daisy chain connection, check the terminating resistor on the last disk drive only. For a star-burst connection, check that the terminating resistor is correctly mounted on all disk drives.
Drive selection address	Check that the disk SCSI ID is set correctly.
Plug setup	Check that the jumpers on the PCA are set so that the disk drive and host computer operate normally. See Section 5.3.
System cables	Check that all system cables are connected correctly.
System diagnostic test	When possible, execute the system level diagnostic routine as explained in the host computer manual. This gives a detailed report of a possible fault.
Intermittent or nonfatal errors	Check the AC voltage from the power supply. Check the DC voltage level at the power connector for the disk drive.
	If the AC voltage level is abnormal or there is a lot of electrical noise, notify the user of the error.
	If the DC voltage level is unstable, replace the power supply unit.
	If possible, replace the disk drive. If replacing the disk drive does not eliminate the error, the removed disk drive is probably not faulty. To continue error analysis, refer to the hardware and software manuals supplied with the system.

6.4.3 Troubleshooting at the repair site

For maintenance at this level, we recommend additional testing of the disk drive and signal checking.

The sense data posted from the IDD helps with troubleshooting. This sense data makes the error type clear (functional, mechanical, or electrical error). Chapter 7 error analysis by sense data, and gives supplementary information on finding the error cause (faulty part).

Table 6.3 lists how to detect a faulty disk drive subassembly. This fault finding requires a working host computer or disk drive test equipment to recreate the error conditions.

If the detected error cannot be recreated in an ordinary test, disk drive conditions can be changed to force the error to recur. This is done by changing the DC voltage or the ambient temperature of the disk drive.

If the error does not recur with changed conditions, the disk drive is not faulty. If no error occurs in the disk drive test, notify the user of the test results, and find out from the user the environment conditions where the disk drive is used.

Table 6.3 Disk drive troubleshooting

Item	Recommended action
Frequent or repeated seek errors	Collect sense data, and see Chapter 7. Replace the disk drive, and check that the test method is correct. If the error recurs, it is likely that the disk drive is normal but the test method is incorrect.
Intermittent or nonfatal errors	Replace the disk drive, and check that the test method is correct. If the error recurs, it is likely that the disk drive is normal but the test method is incorrect. To check performance, change the disk drive conditions by changing the voltage or temperature.

If the disk drive error recurs or a possibly faulty part is found by troubleshooting, return the complete disk drive to the factory for repair. A media defect list must be included with a disk drive returned to the factory.

If the possibly faulty part is the disk enclosure, return the whole disk drive to the factory for repair. Also if a clear error (erroneous servo track information or noisy drive) is detected in the disk enclosure, return the whole disk drive to the factory. A media defect list must be included with a disk drive returned to the factory.

CAUTION

Damage
Never open the disk enclosure in the field. Opening the disk enclosure may cause an irreparable fault.

6.4.4 Troubleshooting with parts replacement in the factory

This manual does not cover troubleshooting at the factory level.

6.4.5 Finding possibly faulty parts

Finding possibly faulty parts in the field was explained in Subsection 6.4.2. This manual does not cover finding possibly faulty parts at the factory level.

CHAPTER 7 ERROR ANALYSIS

This chapter explains in detail how sense data collected from a disk drive is used for troubleshooting. Sense data reflects an error in the disk drive, and helps with troubleshooting.

A sense key, additional sense code, and additional sense code qualifier, taken from various sense data are repeated. Also in this chapter, troubleshooting is performed using these three codes. Unless otherwise specified, "sense data" means the above three codes. When sense data is represented as (x-xx-xx), the leftmost x is a sense key, the middle xx is an additional sense code, and the rightmost x is an additional sense code qualifier.

7.1 Error Analysis Information Collection

7.1.1 Sense data

When IDD posts a CHECK CONDITION status or detects a fatal error in the SCSI bus, the current command or queued command is cleared. In such a case, the IDD generates sense data about the command-issuing INIT. The INIT can read the sense data by issuing a REQUEST SENSE command.

Even if a transfer byte length that is shorter than the sense data length of the tested device is specified, the command terminates normally. In this case, however, the INIT receives part of the sense data, but the remaining part of the sense data is lost.

For details of the REQUEST SENSE command, refer to the SCSI Logical Interface Specifications.

7.1.2 Sense key, additional sense code, and additional sense code qualifier

If an error is detected in a disk drive, the error status is indicated in the sense data collected from the disk drive. Figure 7.1 shows the positions of a sense key, additional sense code, and additional sense code qualifier.

	Bit 7	6	5	4	3	2	1	0
Byte 0	Valid	X'70' or X'71' (error code)						
1	X'00'							
2	0	0	ILI	0	Sense key			
3	[MSB]	Information						
4								
5								
6								[LSB]
7	X'28' (additional sense data length)							
8	[MSB]	Command-specific information						
9								
10								
11								[LSB]
12	Additional sense code							
13	Additional sense code qualifier							
14	X'00'							
15	SKSV	Sense key-specific information						
16								
17								
18	X	0	0	0	SCSI ID			
19	CDB operation code							
20	Detail information							
47								

Bytes 0–17: Basic information
Bytes 18–47: Additional information

Figure 7.1 Format of extended sense data

7.2 Sense Data Analysis

7.2.1 Error information indicated with sense data

Subsection 7.2.2 onwards explain troubleshooting using sense data.

Table 7.1 lists the definition of sense data. For details of sense data, refer to the SCSI Logical Interface Specifications.

Table 7.1 Definition of sense data

Sense data			Definition
Sense key	Additional sense code	Additional sense code qualifier	
00	00	00	Operation was normal.
3	0C	03	A write to a disk terminated abnormally.
4	32	01	Failed to update the defect list due to a disk medium write error, etc.
	40	xx	An error occurred in power-on self-diagnosis.
	C4	xx	A drive error occurred.
1	1x	xx	A disk read error occurred.
3	1x	xx	A disk read error occurred.
E	1D	00	Data discrepancy found by VERIFY command byte check.
5	2x	xx	An SCSI error, such as an invalid operation code, occurred.
	3D	00	The Reserve bit of the IDENTIFY message was set to 1.
	90	00	The RESERVE or RELEASE command cannot be executed because the SCSI ID of the INIT was not posted in the SELECTION phase.
B	44	xx	A hardware error occurred inside IDD.
	47	xx	A parity error occurred in the SCSI data bus.
	49	00	An unmounted or inappropriate message was received.
	4D	xx	Before completion of a command, a command with the same tag number was issued.
	4E	00	An overlap command was issued.

7.2.2 Sense data (3-0C-03), (4-40-xx), and (4-C4-xx)

Sense data (3-0C-03), (4-40-xx), and (4-C4-xx) indicate one of the following:

- A target sector could not be detected using the sector counter.
- A seek process overran the specified time.
- A write to a disk terminated abnormally.
- An error occurred in power-on self-diagnosis.
- A drive error occurred.

The symptoms above are generally caused by an error in a PCA or DE.

For details of the sense data above, refer to the SCSI Logical Interface Specifications.

7.2.3 Sense data (1-1x-xx), (3-1x-xx) and (E-1D-00): Disk read error

If sense data (1-1x-xx), (3-1x-xx) or (E-1D-00) occurs frequently in a specific block of a disk, there is disk damage that was not recorded in the media defect list. In this case, assign an alternate block to the error-detected block using a REASSIGN BLOCKS command. For an explanation of the REASSIGN BLOCKS command, refer to the SCSI Logical Interface Specifications.

If this error occurs in different blocks, a PCA or DE is faulty.

For details of the above sense data, refer to the SCSI Logical Interface Specifications.

7.2.4 Sense data (5-2x-xx), (5-3D-00), (5-90-00), (B-44-xx), (B-47-xx), (B-49-00), (B-4D-xx) and (B-4E-00): SCSI interface error

Sense data (5-2x-xx), (5-3D-00), (5-90-00), (B-44-xx), (B-47-xx), (B-49-00), (B-4D-xx) and (B-4E-00) indicates one of the following symptoms:

- An invalid or unsupported command was issued, or invalid or unsupported parameters were specified.
- A SCSI interface error occurred.
- A hardware error occurred inside IDD.
- A parity error occurred in the SCSI bus.

If this error occurs, a PCA or the SCSI interface cable is faulty.

For details of the above sense data, refer to the SCSI Logical Interface Specifications.

APPENDIX A SETTING TERMINALS

A.1 Setting Terminals (on NP model only)

This appendix describes setting terminals.

A.1 Setting Terminals (on NP model only)

Table A.1 CN2 setting terminal (on NP model drives only)

Setting item	Pins					Setting contents
	1 - 2	3 - 4	5 - 6	7 - 8	9 - 10	
SCSI ID	Open	Open	Open	(Open)		SCSI ID #0 (Common to 8-bit and 16-bit SCSI)
	Short	Open	Open	(Open)		SCSI ID #1 (Common to 8-bit and 16-bit SCSI)
	Open	Short	Open	(Open)		SCSI ID #2 (Common to 8-bit and 16-bit SCSI)
	Short	Short	Open	(Open)		SCSI ID #3 (Common to 8-bit and 16-bit SCSI)
	Open	Open	Short	(Open)		SCSI ID #4 (Common to 8-bit and 16-bit SCSI)
	Short	Open	Short	(Open)		SCSI ID #5 (Common to 8-bit and 16-bit SCSI)
	Open	Short	Short	(Open)		SCSI ID #6 (Common to 8-bit and 16-bit SCSI)
	Short	Short	Short	(Open)		SCSI ID #7 (Common to 8-bit and 16-bit SCSI)
	Open	Open	Open	Short		SCSI ID #8 (16-bit SCSI only)
	Short	Open	Open	Short		SCSI ID #9 (16-bit SCSI only)
	Open	Short	Open	Short		SCSI ID #10 (16-bit SCSI only)
	Short	Short	Open	Short		SCSI ID #11 (16-bit SCSI only)
	Open	Open	Short	Short		SCSI ID #12 (16-bit SCSI only)
	Short	Open	Short	Short		SCSI ID #13 (16-bit SCSI only)
	Open	Short	Short	Short		SCSI ID #14 (16-bit SCSI only)
	Short	Short	Short	Short		SCSI ID #15 (16-bit SCSI only) (*)
Write protect					Open	Write operation is enabled. (*)
					Short	Write operation is disabled.

Setting item	Pins				Setting contents
	11 - 12	13 - 14	15 - 16	23 - 24	
Motor start mode	Open				Started by the START/STOP command
	Short				Started by turning the power supply on (*)
Force Narrow		Open			Width of 16-bit bus (*)
		Short			Width of 8-bit bus
Force Single Ended			Open		Follows DIFFSNS signal level on SCSI bus (*)
			Short		Single-Ended mode
Terminating power supply				Open	Does not supply terminating resistor power to SCSI BUS
				Short	Supply terminating resistor power to SCSI BUS (*)

* Setting at factory shipment

Note:

See the description of Section 5.3 for details of the setting requirements and notes.

APPENDIX B CONNECTOR SIGNAL ALLOCATION

This appendix describes the connector signal allocation.

B.1 SCSI Connector Signal Allocation: SCA2 type LVD 16-bit SCSI

Table B.1 SCSI connector (SCA2 type LVD 16-bit SCSI): CN1

Pin No.	Signal	Signal	Pin No.
01	+12V (Charge)	12V RETURN (GND)	41
02	+12V	12V RETURN (GND)	42
03	+12V	12V RETURN (GND)	43
04	+12V	MATED 1	44
05	Reserved (N.C.)	Reserved (N.C.)	45
06	Reserved (N.C.)	DIFFSNS	46
07	–DB11	DB11	47
08	–DB10	DB10	48
09	–DB09	DB09	49
10	–DB08	DB08	50
11	–I/O	I/O	51
12	–REQ	REQ	52
13	–C/D	C/D	53
14	–SEL	SEL	54
15	–MSG	MSG	55
16	–RST	RST	56
17	–ACK	ACK	57
18	–BSY	BSY	58
19	–ATN	ATN	59
20	–P_CRCA	P_CRCA	60
21	–DB07	DB07	61
22	–DB06	DB06	62
23	–DB05	DB05	63
24	–DB04	DB04	64
25	–DB03	DB03	65
26	–DB02	DB02	66
27	–DB01	DB01	67
28	–DB00	DB00	68
29	–DBP1	DBP1	69
30	–DB15	DB15	70
31	–DB14	DB14	71
32	–DB13	DB13	72
33	–DB12	DB12	73
34	5V	5V RETURN (MATED 2)	74
35	5V	5V RETURN (GND)	75
36	5V (Charge)	5V RETURN (GND)	76
37	N. C.	–LED	77
38	RMT START	DLYD START	78
39	SCSI ID0	SCSI ID1	79
40	SCSI ID2	SCSI ID3	80

B.2 SCSI Connector Signal Allocation: 68 pin type LVD 16-bit SCSI

Table B.2 SCSI connector (68 pin type LVD 16-bit SCSI): CN1

Pin No.	Signal	Signal	Pin No.
01	DB12	–DB12	35
02	DB13	–DB13	36
03	DB14	–DB14	37
04	DB15	–DB15	38
05	DBP1	–DBP1	39
06	DB00	–DB00	40
07	DB01	–DB01	41
08	DB02	–DB02	42
09	DB03	–DB03	43
10	DB04	–DB04	44
11	DB05	–DB05	45
12	DB06	–DB06	46
13	DB07	–DB07	47
14	P_CRCA	–P_CRCA	48
15	GND	GND	49
16	DIFFSNS	GND	50
17	TERMPWR*	TERMPWR*	51
18	TERMPWR*	TERMPWR*	52
19	(Reserved)	(Reserved)	53
20	GND	GND	54
21	ATN	–ATN	55
22	GND	GND	56
23	BSY	–BSY	57
24	ACK	–ACK	58
25	RST	–RST	59
26	MSG	–MSG	60
27	SEL	–SEL	61
28	C/D	–C/D	62
29	REQ	–REQ	63
30	I/O	–I/O	64
31	DB08	–DB08	65
32	DB09	–DB09	66
33	DB10	–DB10	67
34	DB11	–DB11	68

*1 Power supply for the terminating resistor

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